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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

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INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 2890–3780

VOLUME 56 MAY 1953 NUMBER 665

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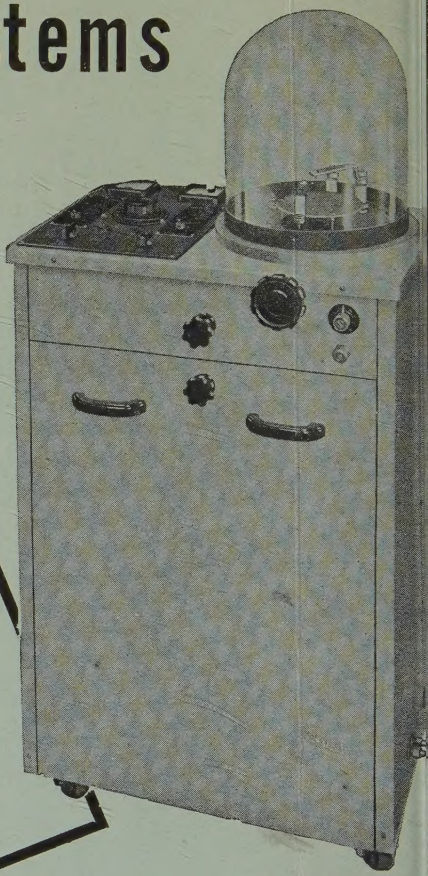

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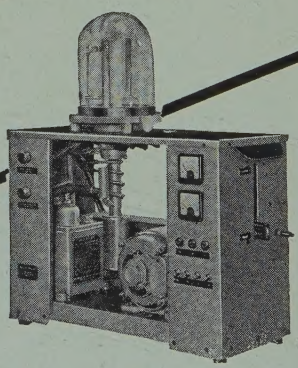

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Analyst	*Analyst.* [Abstracted by *Nuclear Science Abstracts.*]
Izv. Akad. Nauk SSSR Ser. Geogr. Geofiz.	*Izvestiya Akademii Nauk, SSSR, Seriya Geograficheskaya Geofizicheskaya.* [Abstracted by *Meteorological Abstracts.*]
J. aeronaut. Sci.	*Journal of Aeronautical Sciences.* [Abstracted by *Applied Mechanics Reviews.*]
J. appl. Phys. Japan	*Journal of Applied Physics, Japan.* C/o Faculty of Applied Physics, Department of Engineering, Tokyo University, 1 Motofujicho, Bunkyo-ku, Tokyo.
J. Belge Radiol.	*Journal Belge de Radiologie.* [Abstracted by *Nuclear Science Abstracts.*]
J. Soc. Licensed Aircraft Engrs	*Journal of the Society of Licensed Aircraft Engineers.* 6th Floor, Effingham House, Arundel Street, Strand, London, W.C.2.
Receuil Trav. Inst. Rech. Struct. Matière [*Belgrade*]	*Receuil de Travaux de l'Institut de Recherches sur la Structure de la Matière.* Laboratoire de Physique, Belgrade.
Rev. Fac. Engen., Univ. Porto	*Revista da Faculdade de Engenharia, Universidade de Porto.* Oporto.
Rev. S-W	*Revue S-W.* Le Materiel Electrique S-W, 32 Cours Albert I^{er}, Paris (8^{e}).
Stahl u. Eisen	*Stahl und Eisen.* [Abstracted by *Applied Mechanics Reviews.*]
Strahlentherapie	*Strahlentherapie.* [Abstracted by *Nuclear Science Abstracts.*]

Changes of Address

Endeavour	*Endeavour.* North Block, Thames House, Millbank, London, S.W.1.
J. Glaciol.	*Journal of Glaciology.* British Glaciological Society. C/o Scott Polar Research Institute, Lensfield Road, Cambridge, England.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 5274 (1952): **7a**, 763 (*Nov.*, 1952).

Abstr. 6312 (1952): **20**, 1980 (*Dec.*, 1952).

Abstr. 8104 (1952): **39**, No. 23, 546 (1952).

Abstr. 8250 (1952): **9**, No. 11, 281 (1952).

Abstr. 9184 (1952): **3**, No. 5, 981–2 (1952).

Abstr. 204 (1953): **24**, 369 (*March*, 1953).

Abstr. 751 (1953): **21**, 571 (*March*, 1953).

Abstr. 1002 (1953): **21**, 572 (*March*, 1953).

MATHEMATICS 51

517.522.3

2890. A trigonometric series used in physical problems. S. K. LAKSHMANA RAO AND B. S. RAMAKRISHNA. Letter in *Nature* [*London*] **171,** 308–9 (*Feb.* 14, 1953).

The series summed is

$$\sum_{n=1}^{\infty} \frac{\sin(n+\theta)x}{n+\theta} \cdot \frac{\sin(n+\phi)x}{n+\phi}.$$

The sum is expressed in terms of the logarithmic derivative of the γ-function and certain other series, whose sum is known. The series arose in a boundary value problem in room acoustics. See also Abstr. 2676 (1945). L. S. GODDARD

517.54

2891. Construction and applications of conformal maps. Edited by E. F. BECKENBACH. *Appl. Math. Ser. Nat. Bur. Stand. No.* 18, 280 *pp.* (1952).

Proceedings of a symposium held at the Institute for Numerical Analysis of the National Bureau of Standards, at the University of California, Los Angeles, June, 1949. 32 papers are reproduced, the titles of five of which are: *Some industrial applications of conformal mapping,* H. Poritsky (*pp.* 15–30). *Conformal maps of electric and magnetic fields in transformers and similar apparatus,* G. M. Stein (*pp.* 31–57). *Conformal mapping applied to electromagnetic field problems,* E. Weber (*pp.* 59–69). *Conformal mapping related to torsional rigidity, principal frequency, and electrostatic capacity,* G. Szegö (*pp.* 79–83). *Bibliography of numerical methods in conformal mapping,* W. Seidel (*pp.* 269–80).

517.6

2892. Study of the exchange integral and research on the approximate formulae for some integrals appearing in problems of molecular structure. E. SCROCCO AND O. SALVETTI. *Ricerca sci.,* **23,** 98–107 (*Jan.,* 1953) *In Italian.*

The exchange integral

$$\int \phi_a(1)\phi_b(1)\frac{2}{r_{12}}\phi_a(2)\phi_b(2)d\tau$$

has been calculated between Slater's atomic functions p for a set of values of the parameters. Some interpolation formulae are proposed for numerical values of the integrals studied in earlier papers [Abstr. 3776 (1952)] arising in study of the π bonds. A.

517.9 : 656.05

2893. An operational analysis of traffic dynamics. L. A. PIPES. *J. appl. Phys.,* **24,** 274–81 (*March,* 1953).

The dynamics of a line of traffic composed of n vehicles is studied mathematically. It is postulated that the movements of the several vehicles are controlled by an idealized "law of separation." The law considered in the analysis specifies that each vehicle must maintain a certain prescribed "following distance" from the preceding vehicle. This distance is the sum of a distance proportional to the velocity of the following vehicle and a certain given minimum distance of separation when the vehicles are at rest. By the application of this postulated law to the motion of the column of vehicles, the differential equations governing the dynamic state of the system are obtained. The solution of the dynamical equations for several assumed types of motion of the leading vehicle is effected by the operational or Laplace transform method and the velocities and accelerations of the various vehicles are thus obtained. Consideration is given to the use of an electrical analogue computer for studying the dynamical equations of the system. A.

517.93

2894. Solution of nonlinear differential equations by the reversion method. G. I. COHN AND B. SALTZBERG. *J. appl. Phys.,* **24,** 180–6 (*Feb.,* 1953).

By the use of the reversion method certain types of ordinary nonlinear differential equations can be reduced to a set of ordinary linear differential equations which may conveniently be solved by the Laplace transform. The expression for the general member of the linear set is developed and written out in detail for certain illustrative terms. The method is applied to two simple problems for which the answers are exactly known so that some idea may be obtained as to the excellence of the approximations supplied by this method. A.

517.947.43

2895. On the elementary solution of the heat equation. M. KRZYŻAŃSKI. Note in *R.C. Accad. Naz. Lincei,* **13,** 24–5 (*July–Aug.,* 1952) *In French.*

The author's theorem [Abstr. 7683 (1950)] is restated under less restrictive conditions, use being made of results obtained by D. V. Widder [*Trans Amer. Math. Soc.,* **55,** 85–95 (1944)]. R. A. NEWING

518.2

2896. Hexadecimal conversion tables. C.-E. FRÖBERG. *Lund, CWK Gleerup* (1952) 20 *pp.*

Tables for conversions between the decimal system and the system to base 16. The first part deals with integers 0 (1) 1024 (16) 4096. The second contains a table for conversion of decimal fractions. The third consists of frequently used constants. The fourth is a conversion table for hexadecimal fractions to decimal form.

518.5

2897. The use of large scale computing in physics. J. SHELDON AND L. H. THOMAS. *J. appl. Phys.,* **24,** 235–42 (*March,* 1953).

A number of methods of numerical solution of systems of partial differential equations are surveyed. The size and speed of computing machines required to solve problems of varying complexity is discussed. Finally, a number of typical problems which have been solved numerically by various authors are described. A.

518.5 : 621.317.79

2898. Analog computer elements for solving nonlinear differential equations. C. A. LUDEKE AND C. L. MORRISON. *J. appl. Phys.*, **24**, 243–8 (*March*, 1953).

The authors present the design and construction of an analogue computer unit which is particularly well adapted for solving nonlinear differential equations. The units are readily combined to solve simultaneous nonlinear differential equations. The unit is carefully checked by using it to solve some nonlinear differential equations for which known solutions exist. Finally the unit is used to find the solution to some nonlinear differential equations whose solutions are not given in the literature. A.

518.5 : 621.317.79

2899. An electrical computer for the solution of linear simultaneous equations. A. MANY, U. OPPENHEIM AND S. AMITSUR. *Rev. sci. Instrum.*, **24**, 112–16 (*Feb.*, 1953).

An electrical computer, consisting of coils and condensers, for solving symmetrical simultaneous linear equations is described. It employs the network for diagonalizing matrices already described in two previous papers [Abstr. 491 (1948), 4038 (1951)]. The theory of the network, taking into account losses in the coils and errors in adjusting the condensers, is developed. By applying a simple correction to the measured solutions, the errors due to the losses in the coils are eliminated. The accuracy, which then depends only on the accuracy of adjustment of the condensers, is usually a few parts in a thousand. A.

519.2

2900. A guide to tables of the normal probability integral. *Appl. Math. Ser. Nat. Bur. Stand., No.* 21, 16 *pp.* (1952).

This Guide makes available in one place certain information that will be helpful in utilizing the normal probability tables given in standard statistical texts and other important sources, enabling the researcher or student to find quickly which among his books contains the particular form of the function that he seeks. The key should avoid much fumbling in orienting him to the various nomenclatures in use and in clarifying just what the tabulated entries represent. The Guide consists of two main portions. The first portion includes parts I, II, III and IV. Parts I and II tell which sources give tables for the indicated types of segments of area under the normal curve and give the essential characteristics of the tables. These features are succeeded by a description of interpolation methods (part III) especially applicable to certain of the tables mentioned. Then follow two brief comments comprising part IV, giving the relationship between some types of normal tables and other tabulated functions. The second main portion consists of a bibliography, alphabetically arranged by author's name, of the sources referred to in the first portion. (62 entries.)

519.2

2901. A confidence interval for the probability that a normally distributed variable exceeds a given value, based on the mean and the mean range of a number of samples. T. J. TERPSTRA. *Appl. sci. Res. A*, **3**, *No.* 4, 297–307 (1952).

The interval is derived by using the result that, for a normal population, the distribution of the mean range is independent of that of the mean and is nearly a Γ distribution (which can be transformed into a χ^2 distribution). Intervals are calculated for some sets of random numbers; they are slightly wider than intervals based on mean and variance [see Johnson, N. L. and B. L. Welch, *Biometrika*, **31** 362] (1940). A. H. COOK

519.2

2902. On the theory of prediction of nonstationary stochastic processes. G. W. PRESTON. Letter in *J. appl. Phys.*, **24**, 230–1 (*Feb.*, 1953).

The note refers to the form of optimum linear predictor derived by R. C. Davis [Abstr. 8632 (1952)] and points out a development which overcomes the difficulty which Davis's method has in making contact with Wiener's theory of prediction. A. V. BREHME

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.038 : 538.12 : 537.521

Origin of magnetic fields in moving plasma. *See Abstr.* 3324

522.2

2903. The 48-inch Schmidt-type telescope at Palomar Observatory. R. G. HARRINGTON. *Publ. Astron. Soc. Pacific*, **64**, 275–81 (*Dec.*, 1952).

522.53

2904. A double-image micrometer allowing of wide [image] separation. A. DOLLFUS. *C.R. Acad. Sci. [Paris]* **235**, 1477–80 (*Dec.* 10, 1952) *In French.*

Constructional details are given of a double-image micrometer for telescopic use. Special features are a very high resolution, and good correction of astigmatism and transverse chromatic aberration. Its application to the measurement of the diameter and ellipticity of Mars is briefly described: the results are more precise than those obtained by classical methods. D. R. BARBER

522.92 : 535.417

2905. The significance of atmospheric dispersion in astronomical interferometry. W. S. FINSEN. *Circ. Union Obs. [Johannesburg] No.* 112, 82–6 (*Sept.*, 1951).

Describes the effect of atmospheric dispersion on interference fringes, this being a similar effect to the retardation which can be effected by the introduction of a transparent plate into the beam. The theory is fully expounded and various proposals for overcoming the effect of atmospheric dispersion are discussed, particularly the insertion of a variable angle prism between eyepiece and eye. The author does

not agree with a theory of atmospheric dispersion put forward by Maggini. E. G. MARTIN

523.11 : 523.85

2906. Dispersion in the large-scale distribution of galaxies. F. ZWICKY. *Publ. Astron. Soc. Pacific*, **64**, 247–55 (*Oct.*, 1952).

Reviews the work done on galaxies in the universe since Hubble (1936) and gives partial results obtained with the 18 in. and 48 in. Schmidt telescopes. The field of work is enormous but present position indicates that the generally accepted views may be considerably changed. A summary of the programme of future work at Palomar is given, with an indication of the decisions which can be expected from the data thus obtained. For example, decisions are desired on the phenomenon of clustering of galaxies, the relation of obscuring matter to luminous matter and the question of an expanding universe versus a stationary one. E. G. MARTIN

523.16 : 523.852

2907. Luminous intergalactic matter. F. ZWICKY. *Publ. Astron. Soc. Pacific*, **64**, 242–6 (*Oct.*, 1952).

A summary of lines of reasoning that matter must exist in intergalactic space, with an account of the search and discovery of such luminous matter. Filaments between close double galaxies and faint luminous star clouds connecting galaxies separated by distances many times their diameter are announced. These discoveries indicate a higher average density of matter than hitherto accepted and would require a modification of existing theories. A considerable field of work for the future is opened up.

E. G. MARTIN

523.165

2908. Radio frequency emission by cosmic-ray electrons. H. SIEDENTOPF AND G. ELWERT. *Z. Naturforsch.*, **8a**, 20–3 (*Jan.*, 1953) *In German.*

The radiation of primary cosmic-ray electrons in a galactic magnetic field of 10^{-6} gauss is calculated and it is shown that in order to produce the observed radio noise spectrum the electrons must have energies greater than $1{\cdot}4\times10^{9}$ eV and an intensity which is a tenth that of the nucleonic component. H. ELLIOT

523.72

2909. Thermal theories of the high-intensity components of solar radio-frequency radiation. J. H. PIDDINGTON. *Proc. Phys. Soc.* [*London*] *B*, **66**, 97–104 (*Feb.*, 1953).

The high-intensity components of solar radiation are defined as those components whose emitting regions occasionally attain brightness temperatures of 10^{10} deg K or more. They have been referred to individually as enhanced radiation (or noise storms), outbursts and isolated bursts. Theories of origin in terms of thermal processes are examined and none are found capable of explaining the observational data. It is concluded that all three components are generated by the ordered (non-thermal) motion of electrons. A.

523.746

2910. Physical conditions in sunspots deduced from their spectrum. R. MICHARD. *C.R. Acad. Sci.* [*Paris*] **236**, 182–4 (*Jan.* 12, 1953) *In French.*

Some theoretical results based on an empirical model of the surface layers of a sunspot zone [Abstr. 585, 2391 (1953)] are described. The computation of the vertical gradient of magnetic field in the spot zone is discussed. D. R. BARBER

523.755

2911. The localization of Bartel's *M*-regions. A. BRUZEK. *Z. Naturforsch.*, **7a**, 708–11 (*Nov.*, 1952) *In German.*

From a study of daily isophotic-charts of the intensity distribution of the green coronal line on the central meridian of the solar disk, covering the period -10 d. to $+9$ d. from the date of commencement of 3 geomagnetic storms, 1943, 1950, it is found that the exciting region coincides with an area of diminished coronal emission, 40×60 heliographic degrees extent, whose central-meridian-passage occurs *c.* 0·6 d. before the onset of the storm, the time of transit for the solar stream being *c.* 72 h.

D. R. BARBER

523.755

2912. Synthesis of the solar corona. M. WALDMEIER. *Z. Astrophys.*, **31**, *No.* 4, 304–15 (1953) *In German.*

This is the first attempt to calculate the intensities of the coronal emission lines 5303 and 6374 Å along the sun's limb. The observational data are taken for the continuous emission from the photometry of the corona at the eclipse of July 9, 1945, and for the line emissions from observations at the Arosa Astrophysical Observatory on the day of the eclipse. The intensity of the continuous light is proportional to $\int N_e dy$, whereas the line emissions are proportional to $\int N_e^2 dy$. This explains the different behaviour of the continuous and monochromatic coronal emissions. From the results one has to conclude that the distribution of the electrons in the corona shows large irregularities and is sometimes far from the generally accepted spherical distribution. A.

523.77

2913. An attempt to measure interferometrically the widths of chromospheric lines at the total solar eclipse of 25 February 1952. H. A. BRÜCK AND D. A. JACKSON. *Proc. Roy. Soc. A*, **216**, 183–93 (*Jan.* 22, 1953).

An attempt has been made to measure with a Fabry–Perot interferometer the half-value widths of lines of the chromosphere during the total solar eclipse of 25 Feb., 1952. The optical system consisted of a coelostat and concave mirror, an etalon with aluminized quartz plates, quartz fluorite achromats and a quartz spectrograph; the chromospheric spectrum could thus be observed to the limit of atmospheric transmission. The separation of the plates was 3·1 mm, the spectral range 1·6 cm^{-1}, and the resolving power realized was 170 000 over the whole range of spectrum from $\lambda4800$ to $\lambda3100$. This arrangement allowed temperatures to be measured down to 5000°K and turbulence up to 17 km/sec. Besides the lines of H, He and ionized Ca, a number of metallic lines were observed, most of which were blended. No interference fringes were found in any of the lines. Experiments were made to ascertain how far such fringes might be hidden by the uneven structure of the chromospheric arcs. As a result of

these experiments it was concluded that the minimum width of the unblended lines was $1 \cdot 2\ cm^{-1}$, and of the blends $0 \cdot 5\ cm^{-1}$, this lower value being equivalent to 0·06 Å at λ3500 or 0·10 Å at λ4500. A.

523.77

2914. Residual intensity and contour of the solar *K*-line. S. MIYAMOTO. *Z. Astrophys.*, **31**, *No.* 4, 282–97 (1953).

The high residual intensity and the large width of K_2 emission are explained by considering the electron collisions and the non-coherent scattering due to the thermal Doppler effect in the chromosphere. The chromosphere is very opaque for the core radiation. The quanta created by electron collisions within the Doppler core escape through the less opaque wing region by the frequency redistribution. The wing extension of the K_2 emission ceases where the chromosphere becomes transparent for that frequency. The variation of residual intensity according to the fluctuation of the chromospheric electron density is discussed briefly. A.

523.821 : 527 : 551.593.9

2915. The visibility of stars and planets during twilight. R. TOUSEY AND M. J. KOOMEN. *J. Opt. Soc. Amer.*, **43**, 177–83 (*March*, 1953).

From known values of twilight sky brightness, atmospheric transmission, and eye sensitivity, the visibility of planets and stars of magnitudes −2·5 to +4·5 is calculated for the twilight period. The results of the calculations are given in charts which can be applied to various altitudes of the observer and various conditions of observations. The twilight belt is about 1100 sea miles in width, from the sunset or sunrise meridian to full night. The charts show that under good conditions in the first 200 miles of the belt the brighter planets and Sirius become visible, in the next 200 miles first magnitude stars appear, and beyond 500 miles practically all navigational stars can be seen. A.

523.872

2916. Researches on the continuous spectra of stars. V. D. CHALONGE AND L. DIVAN; VI. L. DIVAN. *Ann. Astrophys.*, **15**, 201–36, 237–46 (*July–Sept.*, 1952) *In French.*

V. The apparatus described in previous parts [Abstr. 7004 (1952)] was used at the Jungfraujoch observatory to obtain the absolute gradients in the visual and u.v. regions and the Balmer discontinuity constants D and λ_1 for 150 stars. Results agree with those published in 1941, and are used in a re-investigation of the (D, λ_1) diagram as an accurate means of stellar classification into spectral type and luminosity group [see also Abstr. 7005 (1952)].

VI. Using the above gradients, with Greenwich gradients for longer wavelengths, a comparison of reddened with normal stars indicates that the interstellar absorption is a function of $1/\lambda$, decreasing linearly from 3150 to 4600 Å and more rapidly from 4600 to 6500 Å. D. L. EDWARDS

523.877

2917. Adiabatic pulsations of a particular model of the variable star. R. S. KUSHWAHA. *Proc. Nat. Inst. Sci. India*, **18**, 461–6 (*Sept.–Oct.*, 1952).

The stability of a model in which the density varies in the interior of a star according to the law $\rho_0 = \rho_c(1 - r_0/R)$, where ρ_0 is the density at any point, ρ_c the density at the centre, r_0 the equilibrium value of the distance of the point from the centre and R the radius of the star, has been studied. It is found to be stable, and the period of oscillation and the amplitude of displacement at the different points inside the star are obtained by numerical integration. A.

525.35

2918. The contribution of the seasonal movements of air masses to the variation of latitude. A. YOUNG. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 8–9, 824–37 (1952).

Variations in the products of inertia of the earth are calculated from atmospheric pressure variations. Expressions for the variation of latitude are derived taking damping and possible resonance into account. It is found that, in general character, the variation of latitude is explainable on the assumption that the free motion is subject to random disturbances and that the forced motion is due to seasonal movement of air masses. A.

525.35 : 550.384

2919. On variations of the geomagnetic field, fluid motions, and the rate of the Earth's rotation. E. H. VESTINE. *Proc. Nat. Acad. Sci. U.S.A.*, **38**, 1030–8 (*Dec.*, 1952).

An attempt to explain the observed non-seasonal changes in the yearly rate of the earth's rotation [as recently derived by Brouwer, Abstr. 4118 (1952)], indicating systematic fluctuations since 1820 with a period of about fifty years. Changes in the angular momentum in the atmosphere, oceans, crust and mantle are considered as too small or too slow to be responsible. However, a westward drift of fluid moving near to the surface of the earth's central core is inferred from the westward drift of the earth's eccentric dipole field of terrestrial magnetism (0·30° per year); more complicated northerly and radial drifts of fluid in the core, and of the pole, are also compared. Diagrams represent the position of the pole as a function of time, the fluctuations in core and crustal velocities from 1830 to 1950, as well as the departures in annual rate of rotation of outer core, crust and inner core. It is shown that these geomagnetically deduced fluctuating fluid motions in the earth's central core agree qualitatively with the astronomical requirements. Bullard's model of the earth's core [Bullard, Freedman, Gellman and Nixon, Abstr. 9139 (1950)], attributing these motions to convection, gives in addition also a good quantitative agreement with Brouwer. A. BEER

525.36

2920. Sustained Foucault pendulums. R. S. MACKAY. *Amer. J. Phys.*, **21**, 180–3 (*March*, 1953).

The time-delay or phase-shift effects crucial to the operation of ordinary doorbells and buzzers can be employed to sustain a Foucault (or other) pendulum in a very simple manner, not involving any electrical contacts. Some new electrical effects as well as the pendulum itself are discussed. A.

526.1

2921. Hydrostatic theory of the equilibrium configurations of rotating fluid planets and Stokes's theory in the particular case of the earth. C. MINEO. Note in *R.C. Accad. Naz. Lincei*, **12**, 635–42 (*June*, 1952) *In Italian.*

PHYSICS 53

53.088.7 : 621.317.755.089.6

2922. Precision measurements with a cathode-ray oscilloscope. G. ROBINSON AND R. VAN ALLEN. *Rev. sci. Instrum.*, **23**, 701–6 (*Dec.*, 1952).

Electron optical distortion limits the use of c.r.o. as a measuring instrument but the special calibrating technique described reduces errors to 1%. Static d.c. voltages are applied in steps to one pair of deflecting plates whilst a line trace is produced by the other pair; interchanging connections then results in an orthogonal grid pattern which may be photographed by long exposure method. Fiducial lights arranged around the tube provide reference points for alignment of successive negatives and enable later signal oscillograms to be compared with the calibrated trace. Details are given of a special automatic step-by-step d.c. calibrator. E. D. HART

FUNDAMENTALS 530.1

530.1

2923. Basic methods in transfer problems. V. KOURGANOFF AND I. W. BUSBRIDGE. *Oxford, Clarendon Press* (1952) 298 *pp.*

The first part of this book deals with some fundamental concepts and with auxiliary mathematical formulae. The second part describes the different methods by which transfer problems can be attacked; and the third and final part is devoted to a more general problem, known in astrophysical literature as the non-grey case of Milne's problem. One appendix gives some useful formulae involving the integro-exponential function $E_n(x)$, and another gives various numerical tables, most of which have not been published elsewhere.

530.1 : 523.112

2924. On Mach's principle. H. HÖNL. *Z. Naturforsch.*, **8a**, 2–6 (*Jan.*, 1953) *In German.*

It is suggested that the principle is appropriately expressed as a qualitative relation $\kappa M \sim R$ between the constant of gravitation and the total mass and mean radius of the universe, and is then consistent only with a closed finite universe. R. A. NEWING

530.12

2925. Action as a co-ordinate of space. VII. YU. B. RUMER. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7) 35–48 (1952) *In Russian.*

For Pt VI, see Abstr. 1362 (1953). In this contribution the relation between 5-optics and the relativistic theory of elementary particles of spin ½ is pointed out. Based only on the condition of general covariance of the equations of motion, the theory requires that an additional spin be ascribed to the electron and that its relativistic wave equation be of the form

$$\gamma^k\left(\frac{\hbar}{i}\frac{\partial}{\partial x}\kappa + \frac{e}{c}A_K\right)\psi - imc\psi + \frac{\hbar e}{8mc^2}F_{ik}\gamma^i\gamma^k\psi = 0.$$

Tamm, who first considered this equation, held that in the Coulomb case it does not possess a complete system of orthogonal functions owing to the excessive discontinuity at $r = 0$. The author shows that it is only necessary to consider the rigorous solution of Schwarzschild's equation for a point charge instead of the Coulomb field for reducing the discontinuity of the corresponding wave equation at $r = 0$ to an ordinary one. He also shows that for the spinor equations the presence of an extraneous 5-field may be considered by a generally covariant formulation of the fundamental field equations. It is, however, necessary to abandon the Gaussian metric coefficients $G_{\mu\nu}$ for the Lamé coefficients $\Omega_\mu(\alpha)$. The expression for the symmetric 5-tensor of energy, momentum and charge is obtained by varying the invariant Lagrange function with respect to the metric Lamé potentials, dispensing with the usual canonic formalism. The laws of conservation of energy and charge then appear as consequences of the Hilbert theorem concerning the properties of invariant integrals in gravitation theory. The complex spinor field is investigated in the configuration 5-space of co-ordinates, time and action. In the 5-space of pseudo Euclidean metrics the 5-spinor is a 4-component quantity the components of which transform in rotations of the 5-space according to a 4-row irreductible representation of the group of 5-dimensional rotations. Confining the considerations to transformations of the Lorentz sub-group (x^5 = invar) the 5-spinor decomposes into two 2-component half-spinors, the transformation properties of which are known from Dirac's theory. B. F. KRAUS

530.12

2926. The Schrödinger final affine field laws. V. HLAVATÝ. *Proc. Nat. Acad. Sci. U.S.A.*, **38**, 1052–8 (*Dec.*, 1952).

The field equations are reduced to a system of 2nd-order differential equations for the $n(n+1)$ unknowns $g_{\lambda\mu}$ and F_μ; a 1st-order approx. solution is obtained for the $\Gamma^\nu_{\lambda\mu}$ for the case $n = 4$.

R. A. NEWING

530.12

2927. Certain exact solutions of the equations of general relativity with an electrostatic field. W. B. BONNOR. *Proc. Phys. Soc.* [*London*] *A*, **66**, 145–52 (*Feb.*, 1953).

The solutions are derived, and a physical interpretation is attempted. The canonical cylinder co-ordinates of Weyl are used, and all the solutions in which the electrostatic potential depends on only one of the two variables are obtained. Some of these

are special cases of a class of solutions previously obtained by Weyl and they are shown to correspond either to a uniform electric field or to the field of a line-charge. Two of the solutions are not members of Weyl's class, and in these the electric field has no analogue in classical electrostatics and possesses the property of generating an orthogonal gravitational field. A.

530.12

2928. "Newtonian" time in general relativity. P. C. VAIDYA. Letter in *Nature* [*London*] **171,** 260–1 (*Feb.* 7, 1953).

On the basis of Eisenhart's results (Riemannian geometry) it is suggested that co-ordinates can be chosen in such a way that a radial null vector ω^μ will have $\omega^2 = \omega^3 = \omega^4 = 0$, so that the velocity of light along radial directions is infinite. Several solutions in general relativity take simple forms if expressed in such co-ordinates. Some examples are given. A. J. TAYLOR

530.12 : 538.3

2929. The relativistic electromagnetic equations in a material medium. N. W. TAYLOR. *Austral. J. Phys.*, **6,** 1–9 (*March*, 1953).

It is shown how the general relativistic electromagnetic equations for a material medium can be expressed in the form of a single four-vector density equation. The field tensor has six different complex components instead of three, as in the case of a free medium. The classical equations are obtained by separating the real and imaginary parts. See also Abstr. 22 (1953). A.

530.12 : 512.973

2930. On the representation of physical and geometric quantities by world tensors of ranks 1 and 2. T. SCHLOMKA. *Z. Naturforsch.*, **7a,** 637–45 (*Oct.*, 1952) *In German.*

A scalar s defined in a rest system S_0 can be regarded as the time part of a 4-vector in Minkowski space-time, or can be associated with a world tensor sT^{ij} where T^{ij} is defined in S_0 by a diagonal matrix whose only non-zero elements are ± 1. A 3-vector in S_0 can be represented as the space part of a 4-vector, as part of a 6-vector or as a tensor V^{ij} whose only non-zero elements in S_0 are V^{4j} or V^{i4} where $i, j = 1, 2, 3$. The transformation properties of such representations are considered. The investigation has applications in relativistic mechanics and in the electrodynamics of moving bodies. R. A. NEWING

530.12 : 521.92

2931. Relativity precession of the asteroid Icarus. J. J. GILVARRY. *Phys. Rev.*, **89,** 1046 (*March* 1, 1953).

The relativity precession of the asteroid Icarus is computed to be 10·05″ per century. This value is about one-quarter that of Mercury and exceeds that of any major planet excluding Mercury. Consideration of a figure of merit, which determines the possible precision in measurement of the perihelion advance, indicates that the motion of Icarus can yield a further test of the precessional formula of general relativity. A.

530.12 : 530.145

2932. Unified field theory and Born–Infeld electrodynamics. G. RICKAYZEN AND B. KURSUNŎGLU. Letter in *Phys. Rev.*, **89,** 522 (*Jan.*, 1953).

Kursunoglu's version [Abstr. 1359 (1953)] of Einstein's generalized theory of gravitation reduces to Born–Infeld electrodynamics in the limit of a point charge distribution of an electron. R. H. DALITZ

530.12 : 531.18

2933. The relativistic deformations of a rotating cylinder. II. M. GALLI. Note in *R.C. Accad. Naz. Lincei*, **12,** 569–74 (*May*, 1952) *In Italian.*

For Pt I, see Abstr. 5563 (1952). A critical discussion of the problem of the rotating disk in terms of the special theory of relativity. R. A. NEWING

530.13

2934. On the conservation laws of physics. II. P. JORDAN. *Z. Naturforsch.*, **7a,** 701–2 (*Nov.*, 1952) *In German.*

Suggestions are made for the construction within the framework of special relativity of a generalized electromagnetic theory possessing a double gauge invariance, and thus providing conservation laws for both electric and neutron charge [see Abstr. 4900 (1952)]. R. A. NEWING

530.145

2935. On the new description of quantum-mechanics. H. SHIMOODA. *Progr. theor. Phys.*, **7,** 597–8 (*May-June*, 1952).

Modifies Feynman's particle path formulation of quantum mechanics by introduction of a correlation function, which implies essentially that there are hidden variables for the particles. R. H. DALITZ

530.145

2936. On the quantum and classical problem of irreversibility. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **236,** 277–9 (*Jan.* 19, 1953) *In French.*

Discusses the relation between the use of retarded or advanced waves and the irreversibility of measuring processes. R. H. DALITZ

530.145

2937. The derivative and total differential of an operator. F. DESTOUCHES-AESCHLIMANN. *C.R. Acad. Sci.* [*Paris*] **236,** 354–6 (*Jan.* 26, 1953) *In French.*

Generalized definitions of total derivative and partial derivatives of an operator are given. The total derivative is shown equal to the symbolic current derivative, whence it is deduced that every first integral in quantum mechanics is a first integral in the corresponding classical problem. R. H. DALITZ

530.145

2938. Quantum field theory in the light of distribution analysis. W. GÜTTINGER. *Phys. Rev.*, **89,** 1004–19 (*March* 1, 1953).

It is shown that part of the divergences and ambiguities of the current quantum theory of fields can be overcome by the consistent use of distribution analysis. Representing the singular functions of field theory by distributions, nongauge invariant and non-equivalent terms will be eliminated from the S-matrix in renormalizable as well as in nonrenormalizable theories without any limiting process. Instead of

divergent quantities, there appear arbitrary normalization and division constants. Feynman's cutoff as well as the renormalization are automatically contained in a theory which gives a correct meaning to delta-functions. Applications to closed loop processes are discussed in detail. It is not possible to attribute definite values to the parameters of bare particles; for that, some modifications of the theory seem to be necessary. A.

530.145 : 519.2

2939. Bohm's interpretation of the quantum theory in terms of "hidden" variables. J. B. KELLER. *Phys. Rev.*, **89**, 1040–1 (*March* 1, 1953).

An analysis of Bohm's theory, emphasizing the role of probability in it, is presented. A.

530.145

2940. The field of a charged point-mass. YU. B. RUMER. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 125 (1952) *In Russian.*

For a point-mass an exact common solution of the gravitational and the corresponding electrodynamical equations can be found. In 5-space of coords., time and action, the energy of a point-charge is finite, and becomes infinite in the limiting classical case.

J. JACOBS

530.145

2941. Determination of all the physical quantities possible in a quantized universe. L. FANTAPPIÈ. Note in *R.C. Accad. Naz. Lincei*, **12**, 553–8 (*May*, 1952) *In Italian.*

Scalar quantities are represented as linear operators which satisfy conditions of observability and objectivity [Abstr. 1369 (1953)]. It is shown that such operators are uniquely determined in terms of the fundamental transformation group for the physical system considered. R. A. NEWING

530.145

2942. Operator calculus of quantized operator. I. FUJIWARA. *Progr. theor. Phys.*, **7**, 433–48 (*May–June*, 1952).

The notational ambiguities in Feynman's calculus are all remedied here by setting a more natural foundation of the ordered exponential operators, which will be called briefly "expansional" operators in this paper. The essential point to be stressed is that the pure exponential operator is merely a special case of the wider class of operators, i.e. expansional operators, and the latter type of operators generally appears in quantum mechanics. A clear-cut distinction between these two types of operators is all-important. The so-called disentangling process is a device to decompose any one expansional operator into a product of some simple exponential operators. In the first place the general view-points concerning the expansional operators are presented, in which a rigorous organization of disentangling procedure is accomplished. Next are given some examples treating a generalized forced harmonic oscillator, where the transformation operator is completely disentangled and its representative yields automatically the classical action in its compact form, which process constitutes the original intention of this work. No account is given here of quantized field theory. A.

530.145

2943. Operator calculus in quantized field theory. K. YAMAZAKI. *Progr. theor. Phys.*, **7**, 449–68 (*May–June*, 1952).

Following the suggestion of Feynman, the operators corresponding to the electron-positron field are analysed by means of the operator calculus. Thus Feynman's theory can be deduced operationally from the second quantized theory. With the aid of the external spinors, which are considered as the analogues of the Schwinger's prescribed source, a closed form of the S-matrix was obtained, whence the diffusion equation for the Dirac field can be derived very simply. The relations to the Schwinger's new theory of Green function are also discussed. Finally the formula for multiple boson or fermion pair-production are presented as illustrations of application. A.

530.145

2944. On a relativistic integral equation for bound states. C. HAYASHI AND Y. MUNAKATA. *Progr. theor. Phys.*, **7**, 481–516 (*May–June*); *Erratum:* **8**, 142 (*July*, 1952).

Bound states of two particles are described relativistically by a homogeneous integral equation. Its general properties and reduction to the non-relativistic equation are studied. In the case of scalar particles with scalar photon interaction, if the ladder approximation is taken and the $D^{(1)}$ part of $\delta +$ function omitted, energy levels are obtained relativistically as explicit functions of the fine-structure constant. Difficulties which are met in the case of two spinor particles are discussed. A.

530.145

2945. On the theory of the Green-functions in quantum electrodynamics. R. UTIYAMA, S. SUNAKAWA AND T. IMAMURA. *Progr. theor. Phys.*, **8**, 77–110 (*July*, 1952).

The reformulation of Schwinger's theory of Green-functions is carried out by making use of Tomonaga–Schwinger theory. The physical meaning of several quantities and the relations between Green-functions and the S-matrix are clarified. The general rule for obtaining the Green-functions of many-body problems are derived. The removability of divergences arising in the Green-function of the one-body problem is proved. Ward's identity is derived from the gauge-covariance of Green-functions. A.

530.145

2946. Quantum electrodynamics with auxiliary fields. S. N. GUPTA. *Proc. Phys. Soc.* [*London*] *A*, **66**, 129–39 (*Feb.*, 1953).

A consistent scheme of quantum electrodynamics with auxiliary fields of photons and electrons of infinitely large masses is developed. The auxiliary fields are introduced from the very beginning in the Lagrangian density, but it is ensured by means of suitable initial conditions that these fields are completely unobservable. For some of the auxiliary photon fields the usual sign of the Lagrangian density is reversed, while for some of the auxiliary electrons fields the usual statistics of the field is reversed. For such fields it is found necessary to use an indefinite metric. It is shown that the present treatment provides us with a well-defined procedure for the evaluation of divergent integrals in quantum electro-

dynamics. As an application, the self-energy of the photon is evaluated and shown to vanish for a free photon. A.

530.145

2947. Approximate wave functions for unbound relativistic particles in a Coulomb field. G. K. HORTON AND R. T. SHARP. Letter in *Phys. Rev.*, **89**, 885 (*Feb.* 15, 1953).

The Sommerfeld–Maue approximate solution of the Dirac and of the Klein–Gordon equation for a charged particle moving in a Coulomb field is expressed in momentum space and its relation with higher Born approximations is discussed. R. H. DALITZ

530.145 : 530.12

2948. The mass variation with velocity in the Bopp's unitary field theory. II. M. SUGAWARA AND S. MINAMI. *Progr. theor. Phys.*, **7**, 563–72 (*May–June*, 1952).

For Pt I, see Abstr. 8663 (1952). In the Bopp type non-local field theory the total energy and momentum of the field are calculated, starting from the expression for the energy and momentum tensor recently derived by Y. Ōno and it is shown that the result is the same as that obtained in Pt I, starting from the energy and momentum tensor derived by Bopp. Therefore nothing is modified in the condition for ensuring the four-vector variation of the total energy and momentum of the field, namely the condition for the vanishing of self-stress. Further, it is shown that the two expressions for the energy and momentum tensor are essentially equivalent to each other. As an interesting example a non-local field theory proposed by Pais and Uhlenbeck was examined and it was shown that the condition for the vanishing of the self-stress and the regulator condition for the finiteness of self-energy are satisfied simultaneously in this case. A.

530.145

2949. Note on the non-local interaction. N. SHÔNO AND N. ODA. *Progr. theor. Phys.*, **8**, 28–38 (*July*, 1952).

In order to construct singularity-free classical electrodynamics, Bopp proposed to generalize the field equation and Peierls–McManus attempted the extension of the interaction. The interrelations between these two theories are investigated from the quantum-theoretical point of view. Then two special types of the non-local interaction between electromagnetic field and an electron are proposed, with which the problem of self-charge as well as electron self-energy can be treated satisfactorily. A.

530.145

2950. On the spin of particles with zero rest mass. YU. M. SHIROKOV. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7) 78–82 (1952) *In Russian.*

It is shown that the definition of the spin as an operator according to Abstr. 3291 (1952) is valid also for zero mass. The eigenvalues of the square of the spin are no longer $h^2l(l+1)$. The spin properties of the particle are fully described by a ps. scalar operator without a non-relativistic analogue. W. J. SWIATECKI

530.145

2951. The theory of multiple scattering of particles emitted by a non-isotropic plane δ-source. C. C. GROSJEAN. *Meded. K. Vlaamse Acad. Wetensch.*, **14**, *No.* 13, 33 *pp.* (1952).

An extension of a previous paper [Abstr. 6297 (1952)], in which several problems of multiple scattering in the case of an isotropic point source were solved, leaving the path probabilities and the angular distributions of the single scattering collisions arbitrary. Due to the practical importance of the plane source and in preparation for future work in this field, the case of the non-isotropic plane δ-source has been treated in detail. It is shown that the present problems can be reduced to the solution of some sets of fundamental equations, which are slightly more general than those appearing in the theory of the point source. The solutions involving infinite determinants are studied in detail and a new approximation method has been worked out which is applicable when the scattering functions satisfy a certain condition. A.

530.145

2952. On the well-ordered *S*-matrix. S. HORI. *Progr. theor. Phys.*, **7**, 578–84 (*May–June*); *Erratum:* **8**, 142 (*July*, 1952).

With the help of the relation between *T*-product and *S*-product given by Wick, a new formula for the *S*-matrix has been obtained, which expresses it directly as *S*-product and from which several already known results can be easily derived. A.

530.145

2953. On the structure of the interactions of the elementary particles. II. Does the interaction of the second kind exist in the nature? H. UMEZAWA. *Progr. theor. Phys.*, **7**, 551–62 (*May–June*, 1952).

As shown in Pt I [Abstr. 8672 (1952)] the answer to this question is very important for the formation of future theory of elementary particles. In this paper, those types of fields which may have interactions of the first kind are considered, and then the question whether the model of the mesons can be explained by means of these fields with interaction of the first kind only is discussed. A.

530.145

2954. Interaction of μ meson with matter. II. Spontaneous decay of negative μ meson. T. MUTO, M. TANIFUJI, K. INOUE AND T. INOUE. *Progr. theor. Phys.*, **8**, 13–27 (*July*, 1952).

For Pt 1, see Abstr. 7255 (1951) The negative μ meson decay from the bound state around the nucleus has been worked out. The characteristic differences of the energy spectra of decay electrons and the decay life time of negative μ mesons in comparison with those of positive μ mesons have been pointed out for a number of mass values of the neutral particle $\mu_0 = 0$, $20m$, $40m$ and several forms of couplings of the decay process. The possibility of observing such characteristics of negative μ mesons is discussed briefly. A.

530.145

2955. The *S*-matrix method in pion reactions. T. NAKANO AND K. NISHIJIMA. *Progr. theor. Phys.*, **8**, 53–76 (*July*, 1952).

A new method which is convenient for phenomenological analysis in exploring the mutual correlations among various pion reactions. Correlation

between the photo-meson production and pion-nucleon scattering is discussed. The results seem to be promising in that the ratio: $\sigma(\pi^+p)/\sigma(\pi^-p) = 3$ (at 130 MeV), which can never be deduced from the lowest order perturbation theory, is correctly given. Finally, the method is applied to the qualitative investigation of another process, elastic nucleon-nucleon scattering at extremely high energies, from which it can be concluded that the scattered nucleons will be concentrated in the forward and backward directions in the centre of mass system. A.

530.145

2956. On the interaction of π-mesons with nucleons. B. L. Ioffe and A. P. Rudik. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 127–8 (1952) *In Russian.*

Experimental orders of magnitude of cross-sections for the photoproduction of charged π, capture of π^- by H and scattering of 85 MeV π^- by H (also the magnitude of the π° lifetime $\sim 10^{-14}$ sec), could not be fitted in lowest order perturbation theory using ps. scalar mesons with only one kind of coupling, but suggest ps. scalar coupling $g^2/\hbar c \sim 1$ and ps. vector $f^2/\hbar c \sim \frac{1}{16}$. W. J. SWIATECKI

530.145

2957. Isotopic spin and Coulomb forces. L. A. Radicati. *Proc. Phys. Soc.* [*London*] *A*, **66**, 139–44 (*Feb.*, 1953).

The importance of the Coulomb forces in mixing states with a different isotopic spin T is investigated assuming charge independence of the specific nuclear forces. It is found that for two and four nucleons outside a closed shell in the state $T = 0$ this mixing is very small (less than 0·25%, taking into account interconfigurational mixing). It can therefore be concluded that the Coulomb forces have very little importance in destroying the validity of the isotopic spin selection rules for β and γ transitions and for collisions, which result from the assumption of the charge independence of nuclear forces. A.

530.145

2958. Advances in knowledge of nuclear forces. G. Breit and M. H. Hull, Jr. *Amer. J. Phys.*, **21**, 184–220 (*March*, 1953).

Review article covering work within the last five years preceding the summer of 1952. The principal features of experimental results on nucleon-nucleon scattering are summarized. The main conclusions of the theory of nuclear forces are reviewed with an attempt at a distinction between knowledge and speculation. The photoelectric effect of the deuteron, evidence regarding isobaric states from meson physics, the proof of the pseudoscalar character of the π-meson are briefly discussed as part of the main problem, and a partial account is given of relevant progress in the fields of binding energies of light nuclei and shell theory. A.

530.145

2959. The evaluation of the energy matrix of the tensor forces. I. Talmi. *Phys. Rev.*, **89**, 1065–71 (*March* 1, 1953).

It is shown how the use of tensor operators enables a simple calculation of the tensor forces in nuclear configurations by the usual spectroscopic methods. The number of independent parameters necessary to define the energy in the nuclear configuration l^n (or j^n) is found to be $2l$ (or $2j$), whereas it is shown to be only $[4l/3]$ (or $[2j + 2/3]$) in the l^n (or j^n) configuration of equivalent nucleons. The energy matrix is given by means of a closed formula for the case of d^n and $(d_{5/2})^n$ configurations (of equivalent nucleons). It is found that in the latter configuration the order of levels for a short-range potential (of the tensor forces) is the same as for short-range central forces. A.

530.145

2960. *S*-matrix and causality condition. I. Maxwell field. N. G. van Kampen. *Phys. Rev.*, **89**, 1072–9 (*March* 1, 1953).

The general aim is to obtain maximum information about the *S*-matrix with a minimum of assumptions concerning the interaction. This programme is carried through for the scattering of the electromagnetic field by a fixed centre. The centre is assumed spherically symmetric and of finite size, so that the causality condition can be applied. From this condition it follows rigorously that the *S*-matrix has a one-valued analytic continuation, whose only singularities are poles in the lower half-plane, and whose behaviour at infinity can be specified. Particular consequences are: (i) the analytic properties of Wigner's function R; (ii) the integral relation connecting real and imaginary parts of S; (iii) relations connecting the sum of the oscillator strengths with the scattering cross-section. A.

530.145

2961. First-order meson wave equations. H. S. Green. *Phys. Rev.*, **89**, 965–7 (*March* 1, 1953).

A method is developed for the simple representation of the symbols introduced in the generalization of Dirac's first-order wave equation for the electron. This enables one to obtain an explicit general solution of the generalized equations. The sign of the energy is discussed in order to determine which of the various possible representations are physically admissible. A.

530.162

2962. Generalization of statistics. T. Okayama. *Progr. theor. Phys.*, **7**, 517–34 (*May–June*, 1952).

The possibility of and necessity for a series of statistics, in which a state may at most be occupied with n particles, are discussed and the corresponding distribution function

$$W(\varepsilon) = \left(\sum_{m=1}^{n} m e^{-m(\varepsilon-\eta)/kT}\right) \Big/ \left(\sum_{m=0}^{n} e^{-m(\varepsilon-\eta)/kT}\right)$$

and the formulae for second quantization

$$\sum X_\alpha X_\beta \ldots X_\pi = 0 \text{ for all } \alpha, \beta, \ldots \pi (n+1 \text{ letters}),$$
Perm. among $\alpha, \beta \ldots \pi$

$$X_\gamma X_\alpha^* X_\beta - X_\alpha^* X_\beta X_\gamma = \delta_{\alpha\gamma} X_\beta,$$

$$X_\alpha^n X_\alpha^* + n X_\alpha^* X_\alpha^n = n X_\alpha^{n-1}, \quad \sum_{m=0}^{n} X_\alpha^{*m} X_\alpha^n X_\alpha^{*n-m} = n!$$

and their Hermite conjugate relations, where X_α denotes the annihilation operator and its conjugate X_α^* the creation operator, are established. A.

530.162

2963. On Brownian motion, Boltzmann's equation, and the Fokker–Planck equation. J. Keilson and J. E. Storer. *Quart. appl. Math.*, **10**, 243–53 (*Oct.*, 1952).

In order to describe Brownian motion rigorously,

Boltzmann's integral equation must be used. The Fokker–Planck type of equation is only an approximation to the Boltzmann equation and its domain of validity is worth examining. A treatment of the Brownian motion in velocity space of a particle with known initial velocity based on Boltzmann's integral equation is given. The integral equation, which employs a suitable scattering kernel, is solved and its solution compared with that of the corresponding Fokker–Planck equation. It is seen that when M/m, the mass ratio of the particles involved, is sufficiently high and the dispersion of the velocity distribution sufficiently great, the Fokker–Planck equation is an excellent description. Even when the dispersion is small, the first and second moments of the Fokker–Planck solution are reliable. The higher moments, however, are then in considerable error—an error which becomes negligible as the dispersion increases. A.

530.162

2964. Relativistic statistical thermodynamics. A. E. SCHEIDEGGER AND R. V. KROTKOV. *Phys. Rev.*, **89**, 1096–1100 (*March* 1, 1953).

Bergmann has generalized Gibbs' classical statistical mechanics so as to make it applicable to both relativistic and quantum-mechanical systems. His method, however, involves some complicated differential geometry, and the resulting formulae are not easily manageable. A different method for obtaining a relativistic and quantized statistical thermodynamics is proposed which avoids the differential geometry and gives simpler final formulae. The end results agree with the usual phenomenological relativistic thermodynamics, in which the entropy is a relativistic invariant, while heat and inverse temperature are generalized to be quadrivectors. The new method is essentially to replace the Hamiltonian operator appearing in ordinary quantum statistics by a quadrivector, the energy-momentum operator $\mathcal{B}$. The relativistic canonical ensemble is then defined by the density operator $\mathcal{U} = \text{const} \exp(-\theta\mathcal{B})$, which is Lorentz invariant, for the inner product $\theta\mathcal{B}$ is. Then $k\theta$ (k = Boltzmann's constant) is a quadrivector of inverse temperature, while the entropy S, defined as $S = \text{const. trace}\ (\mathcal{U} \log \mathcal{U})$, is clearly invariant, since $\mathcal{U}$ is. Heat may also be defined, in a way closely analogous to that used in the classical case, as a quadrivector $\delta\mathbf{Q}$ satisfying the relativistic second law $k\theta\delta\mathbf{Q} = dS$. A.

530.162 : 536.7

The statistical aspect of Boltzmann's *H*-theorem. *See Abstr.* 3278

530.162 : 539.11

2965. A theory of cooperative phenomena. III. Detailed discussions of the cluster variation method. M. KURATA, R. KIKUCHI AND T. WATARI. *J. chem. Phys.*, **21**, 434–48 (*March*, 1953).

For Pt II, see Abstr. 784 (1952). A series of approximations for the statistical mechanics of order-disorder, proposed by Bethe, Takagi, Yang-Li-Hill, Kikuchi and others, are investigated in detail in two ways. (1) A new interpretation of the method for constructing the combinatory factor is presented in order to give a better understanding of the nature of approximations. (2) The partition functions with approximate combinatory factors are expanded to compare with the rigorous expansion and the discrepancies between them are investigated in detail. One of the conclusions is that in order to obtain a higher approximation, it is necessary to use the basic figure "closed" with respect to the cluster of the preceding approximation. In appendices, an improved treatment of the body-centred cubic lattice (Ising model) is given, and Bethe's fundamental assumptions are derived from the scheme. A.

530.19 : 538.3

2966. On an extension of electromagnetic fields. B. FINZI. *R.C. Accad. Naz. Lincei*, **13**, 211–15 (*Nov.*, 1952) *In Italian.*

The skew-symmetric field tensor is regarded as the sum of irrotational and solenoidal parts which are defined in terms of two 4-vector potentials. Field equations are derived from a Lagrangian which is a linear combination of quadratic invariants involving 5 universal constants, one having the dimensions of a length and the others being pure numbers. The system includes Maxwell and Yukawa fields as special cases. R. A. NEWING

530.19 : 538.3

2967. On an extended electromagnetic field. P. UDESCHINI. *R.C. Accad. Naz. Lincei*, **13**, 246–53 (*Nov.*, 1952) *In Italian.*

Finzi's equations [preceding abstract] are written in 3-vector form and it is concluded, from a discussion of static fields, that the 5 universal constants can be reduced to 2, one being a pure number μ and the other a length λ. Yukawa fields are given by $\mu = 0$, and Maxwell fields by $\lambda = \infty$. R. A. NEWING

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.01

2968. An alternative formulation of the laws of mechanics. H. M. TRENT. *J. appl. Mech.*, **19**, 147–50 (*June*, 1952).

The author proposes a set of laws of mechanics which are duals of those of Newton. These laws are based upon the concept of the continuity of transmitted forces around closed loops. They are particularly useful in those engineering problems where only knowledge of forces is of interest, since the laws lead directly to equations in which forces are the dependent variables. A.

531.252

2969. On the distribution of stress in a deep beam containing two equal circular holes. B. KARUNES. *Indian J. Phys.*, **26**, 197–200 (*April*, 1952).

The influence of two equal circular holes, placed symmetrically above and below the neutral axis of a deep plate beam on the distribution of stress in it, has been discussed. The values of the circumferential stress over the boundaries of the holes, $\alpha = 0{\cdot}8$ and $\alpha = -0{\cdot}8$ are shown in a graph and discussed. A.

531.539.2 : 548.73

An analogue for the demonstration and selective absorption of coupled wave trains. *See Abstr.* 3736

MECHANICAL MEASUREMENTS 531.7

531.711

2970. The present state of a lightwave standard of length. E. ENGELHARD. "*Maintenance of standards*" *symposium*, 13–23 [see Abstr. 2972 (1953)].

The proposal to establish a lightwave standard of length is reviewed. The basic problem is two-fold: the development of apparatus for the comparison of the lightwave with the metre, and the development of suitable light sources of the chosen standard wavelength. A new interferometric apparatus for the former is described, for the comparison and measurement of end gauges, in which corrections for the refraction of air can be made without the necessity for having the gauges themselves *in vacuo*. The establishment of a lightwave standard of the required precision and reproducibility is discussed in terms of the causes of line-broadening in spectroscopic sources. In particular, the merits of a source using the isotope Kr^{84} cooled to 63°K are mentioned. D. G. AVERY

531.711

2971. The interferometry of length. H. BARRELL. "*Maintenance of standards*" *symposium*, 23–34 [see Abstr. 2972 (1953)].

The development of the use of a wavelength standard of length is reviewed, and new types of spectroscopic sources for such a standard, using the isotopes Hg^{198}, Kr^{84} or Kr^{86}, are described and compared. The techniques and accuracies of interferometric measurements of lengths, both of standard end gauges and of long distances [*c.* 20 m] for geodetic work, carried out at various national laboratories are reviewed. Some discussion is reported. D. G. AVERY

531.711 : 535.22 : 535.24 : 536.5 : 539.16

2972. Recent developments and techniques in the maintenance of standards. *London, Her Majesty's Stationery Office* (1952) 100 *pp*.

Proceedings of a symposium held at the National Physical Laboratory on 21st and 22nd May, 1951. Reported in *Nature* [*London*] **168**, 594–7 (Oct. 6, 1951). For abstracts see Abstr. 2970–1, 2977–8, 2981, 3078, 3080–1, 3264–5, 5539–40, (1953).

531.717.8

2973. Determination of planeness and bending of optical flats. W. B. EMERSON. *J. Res. Nat. Bur. Stand.*, **49**, 241–7 (*Oct.*, 1952).

The true contours, undistorted by gravitational bending, were determined for four $10\frac{5}{8}$ in. diameter standard optical flats of fused quartz. The bending deflections of these flats were determined by a method based upon the differential bending with thickness of the flats. Bending deflection curves of a flat supported at three points equidistant from the centre of the flat and equidistant from each other were obtained. The locus of the bending deflections at the centre of a flat, similarly supported but with supports at different distances from the centre, approximates a straight line. This paper describes the method used to obtain the true contours and the bending deflection curves of the flats, and compares the bending values so determined with theoretically derived values. A.

531.717.8 : 535.823.5

2974. Two methods of measuring the degree of straightness of a microscope stage. R. M. TENNENT. *J. sci. Instrum.*, **30**, 89–90 (*March*, 1953).

Two methods of measuring the degree of straightness of a microscope stage are described. The first makes use of a Michelson interferometer and measures the contribution to the overall noise-level made by the stage. The second depends on an artificially produced straight line as a standard and includes the contribution due to observer errors as well as that due to the stage. A.

531.731.2

2975. Measurement of the volume of solids of revolution. W. M. HAMPTON. *J. Soc. Glass Technol.*, **36**, 327T–329T (*Dec.*, 1952).

A simple method is indicated for the measurement of the volume of a solid of revolution using an ordinary planimeter. The theory is explained and two examples quoted. A.

531.74

2976. The calibration of standards of angle by interferometry. C. F. BRUCE AND W. A. F. CUNINGHAME. *Austral. J. appl. Sci.*, **3**, 210–18 (*Sept.*, 1952).

See Abstr. 4130 (1951). The calibration by interferometry of complete sets of angle standards used in length metrology is described. A detailed account of the departures from flatness and the distortion that occurs in the use of these standards is given. The results confirm earlier conclusions that standards from 3 seconds to 9° are reliable only to several seconds of angle and should be increased in thickness. The standards of larger angle have greater rigidity, but departures from flatness of the surfaces can cause errors of several seconds if they are used in the normal way. A.

531.75

2977. Calibration of load measuring devices. B. L. WILSON. "*Maintenance of standards*" *symposium*, 1–6 [see Abstr. 2972 (1953)].

Descriptions are given of the two dead-weight testing machines of capacities 111 000 and 10 100 lb respectively, installed at the National Bureau of Standards, which serve as the primary standards for the calibration of portable elastic calibration devices. The accuracy and use of the machines are briefly discussed. S. WEINTROUB

531.75

2978. The primary load standard. F. AUGHTIE. "*Maintenance of standards*" *symposium*, 7–11 [see Abstr. 2972 (1953)].

After a brief discussion of the gravitational unit of force and "standard" gravity (980·665 cm/sec²), the 1944 50-Ton dead-weight standard [C. E. Phillips, *Proc. 7th int. Cong. appl. Mech.*, **4**, 268 (1948)] and a new 5-ton standard for the calibration of small proving rings, both at the National Physical Laboratory, are briefly described. Work with resistance strain gauges on compression elements for loads greater than 50 ton is mentioned. S. WEINTROUB

531.752

2979. Improvements in design and construction of quartz helix balances. F. M. Ernsberger and C. M. Drew. *Rev. sci. Instrum.*, **24**, 117–21 (*Feb.*, 1953).

The methods previously used for drawing quartz fibre and winding the fibre into helical springs may be considerably simplified by using a machinist's lathe for both operations. This makes available all the necessary mechanical motions, without constructing special units for the purpose. Fibre may be drawn uniformly to any predetermined diameter between 1·6 and 10 mils and wound with any desired coil diameter and pitch. In the section on helix design, the performance of a helical balance is analysed quantitatively in terms of its sensitivity, load capacity, and loaded length. It is shown that an optimum relationship exists between these characteristics, and a method is developed for specifying the dimensions of the helical balance which will give optimum performance in a given application. A.

531.752

2980. A silica micro-balance; its construction and manipulation, and the theory of its action. R. S. Bradley. *J. sci. Instrum.*, **30**, 84–9 (*March*, 1953).

531.76 : 538.565 : 535.223

2981. The measurement of time, frequency and velocity. L. Essen. "*Maintenance of standards*" *symposium*, 88–100 [see Abstr. 2972 (1953)].

This paper is mainly concerned with the techniques of frequency and velocity measurement. Details of the various mechanical and electrical resonators used as frequency standards are tabulated. The outstanding qualities of the quartz oscillator and its importance as a transfer standard together with the salient features of the various types and the application of quartz standards to the microwave region are discussed in some detail. Tests at the N.P.L. have shown that the cavity resonator at 24 000 Mc/s has a stability from minute to minute of a few parts in 10^8. Results of measurements of the velocity of light (electromagnetic waves) by radar, cavity resonator and optical methods are tabulated and discussed. S. WEINTROUB

531.787

2982. A recording mercurial manometer for the pressure range 0–760 mm of mercury. H. J. Svec and D. S. Gibbs. *Rev. sci. Instrum.*, **24**, 202–4 (*March*, 1953).

A Nichrome *V* or Chromel *A* resistance wire is concentrically positioned in the mercury column of a large bulb manometer. The resistance of this wire is part of a direct current bridge circuit with a recording potentiometer as the balance-indicating device. An electrical circuit which is designed to handle a variety of experimental conditions is presented. A.

531.787.9 : 620.172.222 : 621.317.39

2983. An accurate wire resistance method for the measurement of pulsating pressures. N. Gross and P. H. R. Lane. *J. sci. Instrum.*, **30**, 1–2 (*Jan.*, 1953).

A method of measuring pulsating pressures up to 6000 lb/in² by a wire resistance method is described. The pressure-sensitive element consists of a cylindrical steel tube with a wire winding, incorporated as an arm in a bridge circuit, the output from which is fed without amplication to a mirror galvanometer with a natural frequency of 10 c/s. The records show that a high degree of linearity and stability can be achieved with this combination. A.

531.787.9 : 621.317.79.011.4

2984. Temperature-stable, capacitance pressure gauges. D. C. Pressey. *J. sci. Instrum.*, **30**, 20–4 (*Jan.*, 1953).

A brief theoretical treatment is given of the effect of temperature changes on capacitance pressure gauges. Its use in the design of a sensitive differential pressure gauge of range 0–10 mm of water, having a temperature coefficient of capacitance of only −100 p.p.m./°C, is illustrated. A.

MECHANICS OF FLUIDS 532

532.13 : 541.64

2985. Implications of Philippoff flow curves for the determination of intrinsic viscosity of high polymer nitrocelluloses. C. M. Conrad and H. M. Ziifle. *J. Colloid Sci.*, **7**, 227–35 (*June*, 1952).

The slope of the (log rate of shear)/(log shear stress) curves of Philippoff and Hess (1936) is plotted against log shearing stress, log rate of shear and concentration. Curves of reduced apparent viscosity against concentration for both constant shear stress and rate of shear are obtained and the intercept at zero concentration is found to vary. Similar results are given for cellulose nitrate in butyl acetate. J. E. CAFFYN

532.13

2986. The dependence of the intrinsic viscosity of sodium polyacrylate on salt concentration. P. J. Flory, W. R. Krigbaum and W. B. Shultz. Letter in *J. chem. Phys.*, **21**, 164–5 (*Jan.*, 1953).

Oth and Doty (1952) studied the intrinsic viscosities of partially neutralized polymethacrylic acids and showed that the cube of the linear expansion factor α was proportional to $[\eta]$. Measurements on the completely neutralized sodium salt in water containing various concentrations of NaCl prove that the above holds true for polyelectrolytes. T. C. TOYE

532.137

2987. The measurement of the absolute viscosity of anomalous fluids. I. The measurement of the time-dependence of viscosity of thixotropic materials. S. Thornton. *Proc. Phys. Soc.* [*London*] *B*, **66**, 115–19 (*Feb.*, 1953).

The methods of measuring the absolute viscosity of anomalous fluids are reviewed briefly, and an improved method is given, which is an extension of Mooney's method, and which makes use of a simple concentric cylinder viscosimeter. It is shown that if a suitable technique is used information on the time-dependence of the absolute viscosity of thixotropic materials can be obtained either with this instrument or with a parallel disk viscosimeter. A.

532.137

2988. The measurement of the absolute viscosity of anomalous fluids. II. A comparison of absolute viscosity measurements on instantaneously thixotropic fluids. S. THORNTON AND D. RAE. *Proc. Phys. Soc. [London] B*, **66**, 120–8 (*Feb.*, 1953).

The assumptions inherent in the Rabinowitsch and Mooney methods of measuring the absolute viscosity of anomalous fluids are considered critically, and practical methods are suggested for overcoming the difficulties which arise in these determinations. Absolute viscosity measurements have been obtained on instantaneously thixotropic samples with a suitably modified Poiseuille tube apparatus and a concentric cylinder viscosimeter, and the results are shown to be in agreement within the limits of experimental error over the range of shearing stresses considered. A.

532.5 : 539.374

2989. The hydrodynamics of non-Newtonian fluids. III. The normal stress effect in high-polymer solutions. H. W. GREENSMITH AND R. S. RIVLIN. *Phil. Trans A*, **245**, *No.* 899, 399–428 (1953).

For Pt II, see Abstr. 3789 (1949). Normal stress effects arising in the torsional motion of a cylindrical mass of poly*iso*butylene solution are measured. The precautions which must be taken in making the measurements and the corrections which must be applied to them in order that the results may be compared with theory are discussed in some detail. The distribution of normal stresses over the plane ends of the cylindrical mass and the dependence of this on the experimental conditions is shown to be consistent with the phenomenological theory advanced by Rivlin (1948). From the normal stress measurements, the normal stress coefficient, defined in this theory, is evaluated and the manner in which it depends on velocity gradient is found. Finally, the dependence of the normal stress coefficient on solution concentration and temperature is investigated. A.

532.517

2990. Direct determination of the flow curves of non-Newtonian fluids. II. Shearing rate in the concentric cylinder viscometer. I. M. KRIEGER AND H. ELROD. *J. appl. Phys.*, **24**, 134–6 (*Feb.*, 1953).

For Pt I, see Abstr. 2456 (1952). Another method has been developed for obtaining the rate of shear *v.* shearing stress curves of non-Newtonian fluids from concentric viscosimeter data. The mathematical expression developed is a rapidly converging power series in ln*s*, where *s* is the cup to bob radius ratio. An estimate of error shows that under favourable conditions only two terms of the series are significant, and that terms past the third will hardly ever be needed. A.

532.517.4 : 538.69

2991. Damping of turbulence by a magnetic field. W. MURGATROYD. Letter in *Nature* [*London*] **171**, 217 (*Jan.* 31, 1953).

Describes measurements of the pressure gradient in mercury flowing in a long narrow channel and under the action of a constant transverse magnetic field, and interprets the results on the basis of theoretical work by Lundquist [Abstr. 5916 (1952)]. E. P. WOHLFARTH

532.517.4 : 538.69

2992. On the fundamentals of locally isotropic turbulence in magneto-hydrodynamics of a compressible medium. M. Z. KRZYWOBLOCKI. *Acta phys. Austriaca*, **6**, *No.* 4, 250–6 (1953).

An extension of previous work [Abstr. 2232 (1953)] on the application of Chandrasekhar's theory to the behaviour of compressible media. Account is taken of the interaction between the electromagnetic field and the turbulent motion in the absence of externally applied electric or magnetic fields. E. P. WOHLFARTH

532.525

2993. Effect of weight upon the form of a [horizontal] jet of liquid. C. WORONETZ. *C.R. Acad. Sci. [Paris]* **236**, 271–3 (*Jan.* 19, 1953) *In French.*

By an application of Bernouilli's theory, expressions are derived for the effect of gravity upon the x and y coordinates of the free surface of a jet of liquid issuing from an orifice in the vertical side of a vessel containing the liquid. The coefficient of contraction of the jet varies between 0·611 and 0·674, compared with the classical value $\pi/(\pi + 2) = 0{\cdot}611$ when the effect of gravity is neglected. The theory is applicable to the discussion of other phenomena, e.g. the effect of gravity upon the pressure in the neighbourhood of the jet. J. S. G. THOMAS

532.525 : 539.89

2994. Limiting conditions for jet formation in high velocity collisions. J. M. WALSH, R. G. SHREFFLER AND F. J. WILLIG. *J. appl. Phys.*, **24**, 349–59 (*March*, 1953).

The high-velocity collision of two solids is discussed as a problem in compressible fluid hydrodynamics. Such collisions may conveniently be divided into jetless and jet-forming categories. A theory is presented which describes flow in the collision region for the jetless case and determines a critical collision angle (as a function of material velocities and equation-of-state properties of the materials) above which a jet must arise from the collision. The experimental study of solid collisions utilizes metal plates driven by high explosives, the impact of the plates being recorded with a high speed smear camera. Two experimental arrangements are used, and data for collisions employing Dural, mild steel, brass and lead are presented. Jetless and jet-forming collisions are observed, and critical angles separating the two types are compared with theoretical predictions. Agreement seems sufficiently good to indicate that the theory is valid. A.

532.57 : 621.317.79

2995. A method for adjustment of the zero setting of an electromagnetic flow meter without interruption of flow. A. KOLIN. *Rev. sci. Instrum.*, **24**, 178–9 (*Feb.*, 1953).

Describes a means of establishing the reference point of zero velocity for a flow meter scale without stopping the flow. This is accomplished by introducing two auxiliary electrodes which are disposed so that the voltage picked up by them is independent of the rate of flow. The method of adjustment minimizes artifacts caused by movement of the blood vessel in the magnetic field. A.

532.582.81

2996. The motion of a sphere moving parallel to a plane boundary. F. C. KARAL. *J. appl. Phys.*, **24**, 147–51 (*Feb.*, 1953).

The motion of a rigid sphere moving through an incompressible, homogeneous, nonviscous fluid in the presence of a rigid, infinite plane boundary is examined. The direction of motion of the sphere is assumed to be parallel to the plane boundary. It is assumed that the motion is irrotational and that the sphere velocity is small. An exact treatment is presented. Several curves of the pressure variation on the plane boundary are plotted for different values of the ratio of sphere radius to the perpendicular distance from the centre of the sphere to the plane boundary. A.

532.59

2997. Mass transport in water waves. M. S. LONGUET-HIGGINS. *Phil. Trans A*, **245**, *No.* 903, 535–81 (1953).

A general theory of mass transport is developed, which takes account of the viscosity, and leads to results in agreement with observation. Pt I deals especially with the interior of the fluid. It is shown that the nature of the motion in the interior depends upon the ratio of the wave amplitude a to the thickness δ of the boundary layer: when a^2/δ^2 is small the diffusion of vorticity takes place by viscous "conduction"; when a^2/δ^2 is large, by convection with the mass-transport velocity. Appropriate field equations for the stream function of the mass transport are derived. The boundary layers, however, require separate consideration, given in Pt II, a general theory being developed for two types of oscillating boundary: when the velocities are prescribed at the boundary, and when the stresses are prescribed. Whenever the motion is simple-harmonic the equations of motion can be integrated exactly. A general method is described for determining the mass transport throughout the fluid in the presence of an oscillating body, or with an oscillating stress at the boundary. In Pt III, the general method of solution described in Pts I and II is applied to the cases of a progressive and a standing wave in water of uniform depth. The solutions are markedly different from the perfect-fluid solutions with irrotational motion. The chief characteristic of the progressive-wave solution is a strong forward velocity near the bottom. The predicted maximum velocity near the bottom agrees well with that observed by Bagnold. A.

532.59 : 551.465

2998. Gravity waves. *Circ. Nat. Bur. Stand.*, *No.* 521, 287 *pp.* (1952).

Proceedings of the symposium at the National Bureau of Standards, June 18–20, 1951. 26 papers, 7 abstracts, all on various aspects of the theory and behaviour of liquid waves (except for one paper on the resonance theory of atmospheric tides).

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

2999. The properties of pure liquids. H. S. TSIEN. *J. Amer. Rocket Soc.*, **23**, 17–24, 35 (*Jan.–Feb.*, 1953).

By a semi-empirical approach, a method is found of calculating the specific heat of a normal pure liquid at constant pressure from the specific heat of the gaseous state at the same temperature. It is also found that the coefficient of thermal expansion, the compressibility and the velocity of sound for the liquid can be calculated accurately if the density, the molecular weight and the normal boiling temperature of the liquid at atmospheric pressure are known. Finally, a method of computing the thermal conductivity of all liquids, except liquid metals, from compressibility and density is developed. For normal liquids, the thermal conductivity can again be determined if only the normal boiling temperature, the density and the molecular weight are known. A.

532.7 : 534.22

3000. Experiments on the internal dispersion of supersonic waves in liquids. A. K. DUTTA AND S. K. MUKHERJEE. *Indian J. Phys.*, **26**, 161–70 (*April*, 1952).

It has been observed that the spectral lines, formed by elastic wave diffraction in various liquids, have varying widths. These widths are determined by the discrepancy in the experimental values of α/ν^2 as compared with the value calculated by the Stokes relation, and is not fixed by the actual amount of absorption. It has been considered that when there is complete agreement between the experimental and the calculated values of α/ν^2, like that obtained in the case of castor oil, the line width is determined by the Doppler broadening of the source only, and such a line width may be considered as a standard. Compared with such a standard, the broadening of the spectral lines of different liquids has been measured in terms of dV/V. This has been termed as internal dispersion and is tabulated for two different frequencies. The results are studied in the light of the theoretical expectations. A.

532.7 : 534.22 : 535.32

3001. Molecular motion in fluids and internal dispersion and absorption of elastic and optical waves. A. K. DUTTA. *Indian J. Phys.*, **26**, 142–53 (*March*, 1952).

A theory has been worked out on the basis of molecular motion to determine the absorption and internal dispersion of optical and elastic waves. The present available data on the u.s. absorption have been explained. A general broadening of the lines in the diffraction spectra obtained by the wave field grating has been noted and satisfactorily explained on the basis of a range of elastic wave velocity. The broadening of the spectral lines obtained with the help of a plane diffraction grating has also been noted and attributed to the effect of molecular motion in the liquids. A.

532.7 : 535.32

3002. Experiments on the internal dispersion of optical waves. S. K. MUKHERJEE. *Indian J. Phys.*, **26**, 154–8 (*March*, 1952).

It has been observed that the spectral lines obtained by passing monochromatic light through a plane grating, placed in different liquid media, are broadened to different extents. This broadening effect is a particular characteristic of the liquid, and is determined by the discrepancy between the elastic wave absorption coefficient calculated by Stokes and and the observed value. It has been considered that

this discrepancy, which is a measure of the range of variability of the molecular coefficients, is effective in producing a change in the optical wave velocity also. A.

532.7 : 535.51 : 535.435

An experimental investigation of the dependence of the intensity of the polarized components of Rayleigh scattering of liquids on temperature. *See Abstr.* 3188

532.7 : 536.421.1

3003. Partition functions for relating entropy to disorder in the melting of pure metals. J. F. LEE. Letter in *J. chem. Phys.*, **21**, 382 (*Feb.*, 1953).

The Lennard–Jones and Devonshire partition function for a liquid is modified by taking account of vacant lattice sites and in this way the need to introduce a "communal entropy" factor in the limit of lower densities, is avoided. A. D. LE CLAIRE

532.7 : 537.531 : 535.43

3004. On the theory of fluids. G. S. RUSHBROOKE AND H. I. SCOINS. *Proc. Roy. Soc. A*, **216**, 203–18 (*Jan.* 22, 1953).

The theory of fluids based on the radial distribution function, $g(r)$, is related to the direct correlation function, $f(r)$, of scattering theory. The simplest form of the Born–Green theory is shown to be intimately related to the first approximation to $f(r)$. The second approximation to $f(r)$ is considered in detail, and shown to effect a considerable improvement on earlier theories. It leads to a critical point at which $p/\rho kT = \frac{1}{3}$. Fournet's application of the Born–Green theory to X-ray scattering by fluids is shown to be correct only to the first power in the density ρ. The terms in ρ and ρ^2 are considered in detail for the case of hard spheres. A.

532.7 : 541.64

3005. Dilute solution hydrodynamic behavior of flexible chain molecules: polymethyl methacrylate. T. G. FOX AND L. MANDELKERN. Letter in *J. chem. Phys.*, **21**, 187–8 (*Jan.*, 1953).

Previously derived formulae [Abstr. 3485, 9083 (1950)] are checked with recent data, establishing further proof of their validity. T. C. TOYE

532.72

3006. A rapid method for measuring diffusion coefficients for solutions. F. T. WALL, P. F. GRIEGER AND C. W. CHILDERS. *J. Amer. Chem. Soc.*, **74**, 3562–7 (*July* 20, 1952).

A rapid and inexpensive method has been devised for measuring diffusion coefficients of substances in solution. The procedure consists essentially of soaking a porous disk in the solution of interest and then suspending the disk in a bath of pure solvent. The rate of diffusion of solute from the disk is then ascertained by measuring the apparent weight of the suspended disk at various times. The rate of change of the apparent weight can be directly related to the loss of solute and hence to the diffusion coefficient of the material. The method has been thoroughly tested for aqueous solutions of inorganic salts whose diffusion coefficients are known. The process is sufficiently rapid to permit easy determination of the diffusion coefficients of slowly diffusing substances like high polymers. A.

532.72 : 537.213

3007. Application of potassium permanganate for rendering visible electrical charges produced during diffusion. J. LIMA-DE-FARIA. *C.R. Acad. Sci.* [*Paris*] **235**, 1641–3 (*Dec.* 22, 1952) *In French.*

To give visible evidence of electrical charges formed during diffusion, vertical and thin horizontal tubes have been charged with very dilute KM_2O_4 (3×10^{-4} M) and treated at the base in the former, and at one extremity in the latter, with concentrated HCl. In a short time two zones are observed (in the absence of an electric field) viz., a violet followed by a decolorized zone; when aqueous NaOH is used instead of HCl, the zones are reversed. By means of electrodes in the tubes, curves are constructed giving the variation of potential between two points in the tube as a function of the time. Nothing is observed when only salts are introduced. Disappearance of small fronts in the thin horizontal tubes is attributed to adsorption at the tube walls. H. H. HODGSON

532.73

3008. Quasi-chemical treatment of mixtures of oriented molecules. H. TOMPA. *J. chem. Phys.*, **21**, 250–8 (*Feb.*, 1953).

A simple model of a solution is constructed, assuming that the interaction energies of the molecules depend on their mutual orientation. The thermodynamic properties of the model are calculated by the combinatory method of the strictly regular solution. Graphs of the excess free energy, entropy, and heat of mixing are obtained numerically for a number of typical cases. A.

532.73 : 539.219

3009. Methods of approximation in the theory of regular mixtures. J. A. BARKER. *Proc. Roy. Soc. A*, **216**, 45–56 (*Jan.* 7, 1953).

The quasi-chemical approximation in the theory of strictly regular mixtures is examined, its convergence is proved formally, and the behaviour of the lower approximations is discussed. An alternative generalization of the quasi-chemical approximation for pairs is proposed and found to be equivalent to an approximation developed by Kikuchi. The implications of this alternative approximation are discussed. A.

532.77

3010. On the influence of nonrandomness of mixing in the cell model of solutions. I. SAROLÉA. Letter in *J. chem. Phys.*, **21**, 182–4 (*Jan.*, 1953).

An indication is given of the order of magnitude of the corrections necessary to the cell model of solutions [Abstr. 5584 (1950), 2686 (1952)] when random mixing is not assumed. The conclusions reached in these papers is unaltered by the considerations of the present work. T. C. TOYE

532.77

3011. On the specific molar quantities in the cell model of solutions. J. NASIELSKI. Letter in *J. chem. Phys.*, **21**, 184–5 (*Jan.*, 1953).

See also preceding abstract. The cell model for binary solutions, using the smoothed potential model, is applied to the calculation of partial molar quantities. T. C. TOYE

532.77 : 536.7

3012. Application of the cell method to the statistical thermodynamics of solutions. III. Critical solution phenomena. A. BELLEMANS. Letter in *J. chem. Phys.*, **21**, 369–70 (*Feb.*, 1953).

For previous parts, see Abstr. 5584 (1950), 2686 (1952). Prigogine's extension of the cell method is applied to the problem of critical solution phenomena. Formulae are derived for mixtures of spherical molecules, of the same radius and with isotropic interactions, and the results are compared with those which hold for strictly regular solutions and in the quasi-chemical approximation. E. H. SONDHEIMER

532.782

3013. A study of the supercooling of drops of some molecular liquids. D. G. THOMAS AND L. A. K. STAVELEY. *J. Chem. Soc.*, **1952**, 4569–77 (*Dec.*).

The extent to which various liquid drops may be supercooled has been observed by examining the appearance of clouds of such drops in a beam of light at different temperatures. For most of the liquids studied the great majority of the drops did not freeze until a comparatively narrow range of temperature had been reached far below the melting point. In this range where the drops freeze, spontaneous homogeneous nucleation is assumed to occur. This is discussed in the light of current theories of nucleation phenomena in which a key role is played by the interfacial tension between solid and liquid. An attempt is made to determine values of this quantity, and correlate them with the corresponding heats of fusion. A.

MECHANICS OF GASES 533

533.15

3014. Diffusion in porous catalysts. C. BOKHOVEN AND J. HOOGSCHAGEN. Letter in *J. chem. Phys.*, **21**, 159–60 (*Jan.*, 1953).

The rate of diffusion to the internal surface has been measured for a number of catalysts including (i) a commercial ammonia synthesis catalyst, and (ii) a commercial water gas shift catalyst. For (i) the rate is so slow as to denote Knudsen diffusion alone and to exclude normal gas diffusion and surface diffusion. With (ii) normal gas diffusion is indicated denoting the presence of macropores. S. J. GREGG

533.15 : 533.7

3015. Thermal diffusion of gas mixtures and forces between unlike molecules. B. N. SRIVASTAVA AND M. P. MADAN. *Proc. Phys. Soc.* [*London*] *A*, **66**, 278–87 (*March*, 1953).

The Chapman–Enskog formulae for thermal diffusion in a mixture of gases have been utilized to interpret the data on several gas mixtures at different temperatures but having the same composition. Assuming the Lennard–Jones 12 : 6 interaction potential also for unlike molecules, the minimum mutual potential ε_{12} for interaction between two unlike molecules has been calculated from the temperature dependence of the thermal diffusion ratio k_T. These determinations are expected to provide the most accurate value for this interaction, as thermal diffusion is far more sensitive to the laws of interaction than the other transport properties which have been hitherto used to estimate ε_{12}. The distance r_{12} at which the potential vanishes is calculated from the experimental data on the inter-diffusion coefficient D_{12} by utilizing these values of ε_{12}. Thus ε_{12} and r_{12} are determined purely from experimental data. Equations have been developed to correlate ε_{12} and r_{12} with ε_{11}, ε_{22} and r_{11}, r_{22}, and these relations have been tested with the help of the experimental values. It is found that these theoretical relations give much better agreement than the assumed geometric mean relation for ε_{12} and the arithmetic mean relation for r_{12}. Equations have also been developed for μ_{12} and λ_{12} and their theoretically obtained values compared with the experimental results. A.

533.16

3016. The viscosity of gaseous uranium hexafluoride. A. L. MYERSON AND J. H. EICHER. *J. Amer. Chem. Soc.*, **74**, 2758–61 (*June* 5, 1952).

A series of experiments was undertaken to investigate the reason for the large (10 to 20%) discrepancies between values for the viscosity of gaseous uranium hexafluoride reported by the Manhattan Project and corresponding workers in Great Britain. All investigators used the method of capillary flow to measure the ratio of the viscosity of uranium hexafluoride to air. It was found that with metal capillaries of small diameter the apparent value of this ratio may increase above the laminar value directly and linearly with Reynolds number from values of the latter as low as 10. Finally, accurate values are reported for the viscosity of gaseous uranium hexafluoride in the range 40 to 200° C. A.

533.16 : 536.23

3017. Viscosity and molecular effective diameter of fluorine. E. U. FRANCK AND W. STÖBER. Note in *Z. Naturforsch.*, **7a**, 822–3 (*Dec.*, 1952) *In German.*

The viscosity of gaseous F was measured accurately as a function of temperature, in order to check previous results. The results were corrected for the O impurity of 2·8%. The limit value of the collision diameter for very high temperatures was determined, as well as the diameter for which the mutual potential energy of the particles vanishes after they have passed the Lennard–Jones potential valley of depth ε/k. The results agree with those found from critical data. The thermal conductivity was also calculated and agreed between 90° and 700° K with values found by other methods. In general, the behaviour of F in this respect is similar to N and O, but very different from Cl. A. J. TAYLOR

533.275

3018. The accurate control of relative humidity. R. G. WYLIE AND A. F. A. HARPER. *Austral. J. appl. Sci.*, **3**, 219–27 (*Sept.*, 1952).

A method and apparatus by which the relative humidity in a closed cabinet can be controlled with an accuracy of ± 1 % r.h, are described. The r.h. can be controlled independently of the cabinet temperature or made to depend on it in a predetermined manner. A.

533.5 : 537.534.72

3019. A vacuum lock for routine solid analyses with a mass spectrometer. C. M. Stevens. *Rev. sci. Instrum.*, **24**, 148–51 (*Feb.*, 1953).

A vacuum lock for rapid introduction of solid samples into a mass spectrometer is described. Analyses of the highest resolution requiring high vacuum can be made in five to ten minutes following the introduction of the sample. With an analysis time of about one hour using a surface ionization type of source, six to eight samples can be run in an eight-hour day. The unit is incorporated in a 12-in. 60° mass spectrometer. A.

533.59 : 536.423.1

3020. Studies in high vacuum evaporation. The falling-stream tensimeter. K. C. D. Hickman and D. J. Trevoy. *Industr. engng Chem.*, **44**, 1882–8 (*Aug.*, 1952).

The departure (represented by an "evaporation coefficient") of the rate of evaporation of a liquid from the theoretical value in a molecular still is well known, but the reasons are still obscure. An instrument is described for measuring the rate of evaporation from a hot cylindrical falling stream of liquid to the cooler coaxial walls of an evacuated glass cylinder surrounding it. With this, the rates of evaporation from the new, clean surfaces of two organic liquids [2-ethyl hexyl phthalate (EHP) and 2-ethyl hexyl sebacate (EHS)] were found to be equal to the theoretical values; departures are thus inferred to be due to a surface film. A feature of great theoretical and practical interest was that the composition of the distillate from a given distilland (mixture of the two liquids) varied widely with the rate of distillation (temperature), i.e. the relative volatility $\alpha = y(1-x)/x(1-y)$ increases surprisingly as temperature and rate become lower (x = mole fraction of one component in liquid; y = mole fraction of same component in vapour).

533.59 : 536.423.1

3021. Studies in high vacuum evaporation. Projective and equilibrium vapor-liquid relationships for two binary systems over an extended range. D. J. Trevoy. *Industr. engng Chem.*, **44**, 1888–92 (*Aug.*, 1952).

Since the flow tensimeter (preceding abstract) provided data different from recent equilibrium tensimeters and since the relative volatilities increased with decrease of rate, it became highly desirable to explore the temperature, pressure, rate and composition relationships of the test mixtures over an extended range in both projective and equilibrium tensimeters. Measurements were made in the flowing-stream instrument and in an improved equilibrium still (described in the next abstract but one) at vapour pressures of 1 to 100 μ over the entire range of compositions from 0 to 100 in 10% steps. The mixture of EHP and EHS showed relative volatilities which were identical in the two instruments below 2 μ. At higher pressures, the separations were relatively better in the equilibrium still. The relative volatilities at all temperatures were independent of liquid composition but showed deviations from Raoult's law. A.

533.59 : 536.423.1

3022. Studies in high vacuum evaporation. Surface behavior in the pot still. K. C. D. Hickman. *Industr. engng Chem.*, **44**, 1892–902 (*Aug.*, 1952).

When liquids are permitted to evaporate rapidly and without restriction into a high vacuum, their surfaces often separate into two zones of widely different appearance and properties. One, which is in rapid self-motion, is called "working," and the other, which is quiet and highly reflecting, is called "torpid." The dual or "schizoid" condition is the usual habit and there is a well-defined barrier between the two kinds of surface. Schizoid phenomena were studied with an evacuated flask, warmed from below and cooled above, which became a molecular pot still under total reflux. A miniature anemometer was moved as a probe within the flask to measure the emission of vapour from various portions of the surface. The torpid area emitted 2 to 1000 times less vapour than the working area. The working area was depressed below the torpid to a depth corresponding with the differences of the recoil pressures of the emergent vapours. The torpid area became more permeable when placed under lateral tension, less so under compression. Torpidity is a flotation phenomenon and the torpid area can be overflowed, rendering some, but not all, liquids permanently working. Torpidity is believed to be due to traces of impurity that block the surface during rapid evaporation. Most liquids in everyday use exhibit torpidity when evaporated into a high vacuum at rates of 1 to 1000 microns. Torpidity is thus the extra factor that contributes to the "vacuum pot-still effect" and probably accounts in part for the low evaporation coefficients reported in the literature. A.

533.59 : 536.423.1

3023. Studies in high vacuum evaporation. Comparison of high vacuum stills and tensimeters. K. C. D. Hickman and D. J. Trevoy. *Industr. engng Chem.*, **44**, 1903–11 (*Aug.*, 1952).

A tensimeter has been devised in which splashless agitation is provided by a cylinder rotating on a horizontal axis and equilibrium is ensured by drastic limitation of escape of vapour, the data defining an equilibrium theoretical plate (perfect unit act) of distillation. The methods and measurements assembled in the first two papers were extended by other means, and the data define a projective theoretical plate. Datum lines were constructed graphically against various co-ordinates and applied to the evaluation of well-known types of stills. Using the "barrel tensimeter," highest and reproducible equilibrium values were secured when the effective area of escape (admittance of neck) was less than $\frac{1}{500}$ the area of evaporation. The equilibrium instrument gave better separations than the projective. The expanding surface of a "push-pull" tensimeter had the unique property of giving better separations than the equilibrium instrument. The laboratory 5 in. centrifugal molecular still followed the projective datum line to the fastest rates of distillation, whereas the falling-film still met it for a short distance. All unstirred, unjacketed pot stills fell far below, registering $\frac{1}{3}$ to $\frac{1}{2}$ plate; stirred and carefully lagged

pots gave values above the line, evidently because of redistillation of reflux. A.

533.6.011

3024. A transformation of the hodograph equation and the determination of certain fluid motions. T. M. CHERRY. *Phil. Trans A*, **245**, *No.* 904, 583–626 (1953).

A transformation is given of the hodograph equation of two-dimensional gas dynamics, from the usual variables q, θ to q and a new variable ϕ. The transformation, which suits any gas for which $p\rho^{-\gamma} = \text{const.}$ with $\gamma > 1$, is so chosen that certain solutions, which in terms of q, θ are multiple-valued, become single-valued functions of q, ϕ. Such a solution is represented, over the whole domain which is of interest, by a single series in q, ϕ, which is rapidly convergent; whereas in terms of q, θ different series would be required for different branches of the function, and these would be but slowly convergent. By this method can be constructed (i) the nozzle flow for which the axial velocity is a prescribed analytic function of position, in particular trans-sonic nozzle flows; and (ii) various cases of flow past aerofoil-shaped cylinders placed in a uniform stream. Taking $\gamma = 1{\cdot}4$, complete numerical results are given for one case of trans-sonic nozzle flow, and from these other such flows can be obtained by superposition, and a family of flows of type (ii) is investigated, in which the trailing edge of the aerofoil is cusped; the aerofoil shape has been calculated for two representative values of the free-stream Mach number. A limiting flow of this family is found to consist of a set of Prandtl–Meyer flows, analytically distinct but joining continuously where they abut. These flows are related to a particular solution of the hodograph equation which is of fundamental analytic importance; it stands in the same relation to the set of "Chaplygin solutions" as the generating function for Legendre polynomials does to the harmonic functions $r^n P_n(\cos\theta)$. A.

533.6.011.5

3025. An estimate of viscosity effect on hypersonic flow over an insulated wedge. S.-F. SHEN. *J. Math. Phys.*, **31**, 192–205 (*Oct.*, 1952).

In the case of hypersonic flow over a slender wedge, neglect of viscosity leads to the result that the shock wave is straight and lies very close to the surface of the wedge. The ratio of the shock wave angle to the vertex angle of the wedge depends only on the hypersonic parameter $K = M^0\beta$, where M^0 is the free-stream Mach number and β is the semi-vertex angle of the wedge. As, by the definition of hypersonic flow, the value of β is small, it follows that the absolute thickness of fluid between the shock wave and the wedge surface is very small, and the effect of a viscous boundary layer would be felt. An estimate of this viscosity effect is derived for the case of an insulated wedge over which flows an air stream, of Prandtl number unity, by the "Pohlhausen method," used in the discussion of ordinary boundary layer problems. The flow is assumed to be laminar, and the air to satisfy the equation $p = \rho R'T$. It is shown that the Reynolds number, R, of the flow enters into the solution as a scale factor of the length of the wedge only. At different R values, the shock wave shapes are similar, provided K is constant. At a given wedge, the absolute length over which the viscosity effect is important increases when R is small and K large, e.g. for $K = 1$ and $\beta = 5°$, in flight in free air, the viscosity effect might be negligible. But in a hypothetical hypersonic wind tunnel, in which the desired value of M^0 is obtained by expansion of the air from nearly atmospheric conditions, R may be so low that a discernibly-curved shock wave occurs. Under such circumstances, drag measurements, excluding the contribution due to base drag, would be very different from the pressure drag of inviscid theory. The analysis should help to give a better interpretation than hitherto, of the correlation between free-air and wind-tunnel results. A solution for the case of flow over a flat plate is derived by making $\beta = 0$, and the solution in the case of a heat conducting wedge, with the Prandtl number $\neq 1$ is briefly discussed. J. S. G. THOMAS

533.6.05 : 535.71

3026. A temperature-sensitive phosphor used to measure surface temperatures in aerodynamics. L. C. BRADLEY, III. *Rev. sci. Instrum.*, **24**, 219–20 (*March*, 1953).

A thin sheet of a temperature-sensitive phosphor has been used to show the distribution of temperature on the surface of a flat plate in supersonic flow. Calibration of the phosphor is described, and a photograph is shown. Use of a photomultiplier tube permits one to determine the temperature as a function of time, from which recovery temperatures and heat transfer coefficients may be deduced. A.

533.6.08

3027. A technique for cleaning hot-wires used in anemometry. L. A. WYATT. *J. sci. Instrum.*, **30**, 13–14 (*Jan.*, 1953).

When a hot-wire is exposed to an air-stream near an industrial area, it collects a deposit consisting of particles of soot and tar. The deposit, by changing the heat-loss from the wire, can decrease the sensitivity by as much as 20%. Even in cleaned air, the useful life of a hot-wire may be no more than 2 hours. It has been found that repeated measurements of turbulent velocity, under the same conditions but using different wires, differ from one another by 4% or more. A technique has therefore been developed for cleaning hot-wires, so that a single wire can be used repeatedly; the sensitivity then remains constant to within 2%. Making use of this technique, measurements of turbulent velocity have been reproduced to within ½%. A.

MOLECULAR THEORY OF GASES 533.7

533.7

3028. Probability that two diffusing molecules will collide. R. A. WIJSMAN. *Bull. math. Biophys.*, **14**, 121–6 (*June*, 1952).

A formula is derived for the probability $P(r_1)$ that two molecules, originally at a distance r_1 from each other and moving in an infinite scattering and absorbing medium, will eventually collide with each other. A.

533.7

3029. On the inelastic collision between molecules. I. K. TAKAYANAGI. *Progr. theor. Phys.*, **8**, 111–19 (*July*, 1952).

The energy transfer between vibration and translation in molecular collisions is investigated for the linear configuration of two diatomic molecules. The method of calculation is completely parallel to that of Jackson and Mott. The results are applied to the interpretation of the experimental facts for anomalous supersonic dispersion, and qualitative successes are obtained. A.

533.7 : 537.311.37 : 536.23

Transport phenomena in a completely ionized gas. *See Abstr.* 3231

VIBRATIONS . ACOUSTICS 534

534.12 : 534.24

3030. Surface motion associated with obliquely incident elastic waves. J. PEARSON AND J. S. RINEHART. *J. Acoust. Soc. Amer.*, **25**, 217–19 (*March*, 1953).

Well-known laws which govern the reflection of elastic waves that strike free surfaces obliquely are used to deduce particle motion at the free surface of a body. The surface particle motion is presented in the form of diagrams and graphs for the case of an incident longitudinal wave. Considerations indicate that, for oblique incidence, the particle motion at the surface will not, in general, be perpendicular to the surface but will depend on the angle of incidence and the Poisson's ratio of the material. The data are expected to be of value in the solution of problems connected with impulsively loaded bodies such as metal-explosive systems. A.

534.121.1 : 532.582.5

3031. A study of vanes singing in water. C. A. GONGWER. *J. appl. Mech.*, **19**, 432–8 (*Dec.*, 1952).

In the course of propulsion experiments with ring-channel and rotating-boom, it was discovered that certain struts which are used to support underwater bodies would "sing" at surprisingly low speeds, e.g. 5 to 7 knots. Tail surfaces also sang. The note emitted was a clear musical tone in most instances, and, as the speed was increased, the note would fade, disappear and then reappear as a note of higher frequency. This singing caused considerable apprehension as it was feared that the strut would fail at high speeds due to build-up of the vibrations. Analysis for flutter stability and torsional divergence had been conducted, and it was known that the operation was well away from the ranges where flutter or torsional divergence might occur. However, the severity of the singing did not tend to become greater at high speeds, and there were usually quiet speed zones at high speeds as well as at low speeds. A.

534.13

3032. The propagation of a pulse between plane parallel plates. D. V. ANDERSON. Letter in *J. Acoust. Soc. Amer.*, **25**, 154 (*Jan.*, 1953).

The problem is shown to be theoretically similar to that of a pulse propagated through a circular cylinder. Experiments carried out on water confined between two parallel plates have been carried out and the agreement with theory is shown pictorially.

T. C. TOYE

534.13 : 532.3 : 532.623

3033. The flexural response of a submerged solid to a pulsating gas bubble. G. CHERTOCK. *J. appl. Phys.*, **24**, 192–7 (*Feb.*, 1953).

A bubble in a liquid pulsates and generates a changing pressure field. This reacts with a submerged flexible solid and induces elastic motions. Equations are derived which show how the vibration modes and frequencies of the solid are modified by the presence of the water, and how each mode is excited by the bubble pulsation. The generalized force for each mode is proportional to the volume acceleration of the bubble. The initial analysis presupposes incompressive flow, but it is shown that the results remain applicable if the duration of any compressive phase is small compared with the pulsation period of the bubble and the vibration period of the solid. A.

534.131 : 534.231

3034. Vibrations of elastic shells in a fluid medium and the associated radiation of sound. M. C. JUNGER. *J. appl. Mech.*, **19**, 439–45 (*Dec.*, 1952).

This is a study of the vibrations of thin elastic shells freely suspended in a compressible fluid medium. The effect of the fluid reaction on the dynamic characteristics and, in particular, on the natural frequencies is investigated for cylindrical and spherical shells. The dynamic configuration of such shells undergoing forced vibration and the associated radiation of sound are determined. The problem is analysed by means of the classical methods of the theory of mechanical vibrations; the Lagrange equations for the system are derived, the fluid reaction being introduced in the form of generalized forces. From the boundary condition that the normal shell deflection be equal to the normal fluid-particle displacement at the shell surface, and introducing the concept of acoustic impedance, it is shown that the fluid reaction is equivalent to an accession to the inertia of the shell and to a damping force. Numerical examples show that the effect of the fluid reaction on the dynamic characteristics of a shell may be of such magnitude as to render valueless calculations neglecting it. A.

534.152

3035. Experimental technique used to measure transient waves through solids. W. A. ALLEN AND C. L. MCCRARY. *Rev. sci. Instrum.*, **24**, 165–71 (*Feb.*, 1953).

An experimental technique, based upon the principle of the optical lever, has been used to measure surface oscillations as small as 10_{μ} in amplitude on a thick circular plate, while it deforms under explosive attack. The transient behaviour of the plate was determined by means of a long focal-length, sweeping-image camera with a writing speed of 4 mm/$_{\mu}$sec. In comparison with the Hopkinson' method, the technique yields more information of equivalent, or greater, accuracy. Equations are derived that have been used in the analysis of the experimental data. Experimental results are given as an indication of the precision of the technique. A.

534.17

3036. The measurement of the lateral mechanical impedance of phonograph pick-ups. J. G. WOODWARD AND J. B. HALTER. *J. Acoust. Soc. Amer.*, **25**, 302–5 (*March*, 1953).

A device is described for measurement of the complex impedance between 30 and 10 000 c/s. It employs four electromagnetically driven, calibrated vibrators resonating at different frequencies. The theory of operation is outlined, and results obtained for a typical pick-up are presented. A.

534.21

3037. On longitudinal plane waves of elastic-plastic strain in solids. D. S. WOOD. *J. appl. Mech.*, **19**, 521–5 (*Dec.*, 1952).

A theoretical description is given for the propagation of longitudinal plane waves of large lateral extent in solids, for waves of plastic as well as elastic strain. The importance of the hydrostatic compressibility in determining the nature of the waves is brought out. The results are illustrated by a computation of the velocities of propagation of such waves in 24S-T aluminum alloy, and by a computation of the propagation of a pressure pulse of short duration through a flat plate. The later results illustrate the attenuation and change in shape of the pressure pulse during its propagation. The effects of the pressure dependence of the compressibility, the temperature changes accompanying compression, and the time and rate dependence of the mechanical properties, upon the propagation of such waves are discussed qualitatively. A.

534.21

3038. Finite amplitude sound waves. J. B. KELLER. *J. Acoust. Soc. Amer.*, **25**, 212–16 (*March*, 1953).

Exact solutions of the one-dimensional gas dynamic equations, representing periodic sound waves of finite amplitude, are obtained for a particular medium. The progressive wave from a vibrating piston and the standing wave in a closed tube are examined in detail. Limits on the amplitude of the sound wave are found in order to avoid shocks or cavitation. A.

534.21 : 534.322.3

3039. The theory of noise in continuous media. C. ECKART. *J. Acoust. Soc. Amer.*, **25**, 195–9 (*March*, 1953).

It is shown that the mathematical solution of problems involving the propagation of noise is materially aided by the introduction of the space correlation function $\psi(x_1, x_2, \tau)$, defined as the average, over t, of $p(x_1 t)p(x_2 t - \tau)$, p being the acoustic pressure in the noise field. The differential equations satisfied by ψ are derived. Its relation to $\Psi(\alpha, \beta, \gamma)$ is discussed, α, β, γ being the propagation vector of a sinusoidal wave, and $\Psi/2\rho c^2$ being the density of potential energy in the α, β, γ space. The theory of uniform noise fields, both isotropic and anisotropic, is developed in detail. The anisotropy caused by a reflecting plane is discussed. The radiation of noise by a vibrating plane is discussed, neglecting the reaction of the radiation on the motion of the surface. In particular, it is shown that to this approximation the sea surface cannot radiate subsonic energy into the high atmosphere because the velocity of the surface gravity waves is less than the velocity of sound in air. The theory of noise, as here developed, is analogous to the theory of turbulence, and the relation between noise and turbulence is briefly discussed. A.

534.22/.23 : 612.1

3040. Determination of the acoustic properties of blood and its components. E. L. CARSTENSEN, KAM LI AND H. P. SCHWAN. *J. Acoust. Soc. Amer.*, **25**, 286–9 (*March*, 1953).

Measurements of absorption and velocity of sound in blood, plasma, and solutions of albumin and haemoglobin have been carried out in the frequency range 800–3000 kc/s and temperature range 5–45° C. The absorption departs only slightly from a linear dependence upon frequency. Absorption for the various solutions is in direct proportion to protein content. It is concluded that the acoustic properties of blood are largely determined by the proteins which it contains. A.

534.22

3041. Velocity of ultrasound in argon up to pressures of 950 atmospheres. A. LACAM AND J. NOURY. *C.R. Acad. Sci.* [*Paris*] **236**, 362–4 (*Jan.* 26, 1953) *In French.*

Experimental results are given for the velocity of sound of frequency 900 kc/s in specially purified argon. The method employed was that of diffraction of light by ultrasound and the accuracy claimed is better than 1%. The velocity increases from 331 m/sec at 91 atm. to 700 m/sec at 919 atm., the variation being almost linear. A. B. WOOD

534.22 : 532.7

Experiments on the internal dispersion of supersonic waves in liquids. *See Abstr.* 3000

534.22 : 535.32 : 532.7

Molecular motion in fluids and internal dispersion and absorption of elastic and optical waves. *See Abstr.* 3001

534.222.2

3042. Attenuation in the shock tube. R. J. EMRICH AND C. W. CURTIS. *J. appl. Phys.*, **24**, 360–3 (*March*, 1953).

By timing the successive arrivals of a shock at stations placed along the channel of a shock tube, measurements have been made of the decrease in shock velocity with travel. These measurements were carried out for shocks moving into air at atmospheric pressure. The attenuation per unit length of travel is greater for stronger shocks and in smaller tubes. Representing distance along the tube by x and using fractional increase in pressure across the shock, $(P - P_0)/P_0 = z$, as a measure of shock strength, the dimensionless quantity $R(dz/dx)/z$ is found to lie in the interval $(3{\cdot}5 \pm 2) \times 10^{-4}$ for shocks ranging in strength $0{\cdot}1 < z < 1{\cdot}0$ and in tubes of hydraulic radius $0{\cdot}30 < R < 3{\cdot}80$ cm. It is believed that this attenuation is due to wall interaction rather than to nonideal rupture of the diaphragm. However, the exact physical nature of this interaction has not as yet been determined. A.

534.23 : 534.321.9

3043. The behaviour of ultrasonics in liquids. J. LAMB. *Research*, **5**, 553–60 (*Dec.*, 1952).

The paper describes the results of recent research

work connected with the properties which liquids exhibit to ultrasonic waves. Particular attention is given to the measurement and interpretation of relaxation effects in pure liquids, electrolytes and polymer liquids. Emphasis is placed on the physical interpretation of these processes and the influence which they have on the propagation of a sound wave. A description is given of two new methods of measurement, namely the high-frequency pulse technique and the low-frequency reverberation method. (Bibliography, 49 items.) A.

534.23

3044. Notes on the transmission of sound through plates. R. D. Fay. *J. Acoust. Soc. Amer.*, **25**, 220–3 (*March*, 1953).

A relatively tractable expression for the transmittivity of steel plates immersed in a fluid medium is formulated. Criteria for total transmission and total reflection are inherent in the expression. An investigation of the discrepancies between calculated and observed transmittivity indicates a probability that the assumption of negligible losses associated with shear waves in steel is not tenable. A.

534.23

3045. The dependence of intensity of sound at source on its absorption coefficient in liquids. S. Parthasarathy, S. S. Chari and D. Srinivasan. Letter in *J. chem. Phys.*, **21**, 185 (*Jan.*, 1953).

Employing a radiation pressure method the ratio $I_0/(\alpha/\nu^2)$ (where I_0 is intensity at source, α absorption coefficient, ν frequency) is measured for a number of liquids at 5 and 15 Mc/s. This ratio is found to be constant at 5 Mc/s for all except anomalous absorbing liquids such as benzene and carbon disulphide. At 15 Mc/s the ratio is not constant for any of the liquids whether anomalous or not. T. C. Toye

534.23

3046. Absorption of sound in argon, nitrogen, and oxygen at low pressures. J. G. Parker, C. E. Adams and R. M. Stavseth. *J. Acoust. Soc. Amer.*, **25**, 263–9 (*March*, 1953).

The amplitude absorption coefficient α for pulsed sound waves in A, N and O has been measured over a range of pressure p from 1 to 10 mm Hg for frequencies f between 60 and 70 kc/s, the temperature in all cases being held nearly constant at 20° c. For the three gases used, the following experimental values of $(p\alpha/f^2)10^7$ (c.g.s. units) were obtained: (1) for A 1·86 with an r.m.s. deviation of 0·03; (2) for N 1·64 with an r.m.s. deviation of 0·04; and (3) for O, 1·92 with an r.m.s. deviation of 0·03. The corresponding values computed from the classical absorption equation are (1) for A, 1·87; (2) for N, 1·31; and (3) for O, 1·61. Thus the absorption in A is classical while for N and O the absorption exceeds the classical value. These excesses are attributed to rotational relaxation and the associated relaxation times are calculated in accordance with the thermal relaxation theory of Herzfeld and Rice, and Kneser. For N, the relaxation time (reduced to S.T.P. conditions) is $4{\cdot}85\times10^{-10}$ sec and for O is $4{\cdot}95\times10^{-10}$ sec. Both these values are significantly smaller than the values obtained by other workers at higher frequencies. A.

534.231

3047. The sound field of a piston source. E. W. Guptill. *Canad. J. Phys.*, **31**, 393–401 (*March*, 1953).

An exact solution is presented for the sound field between two infinite walls when the source is a piston in one of the walls. A method is also outlined for the case of a source having any amplitude distribution which is a function only of radial distance from the centre of the source. Several graphs are shown and they are intended to illustrate how the pressure on a receiving crystal would vary when the wall separation is changed. A.

534.231

3048. Second-order acoustic fields: relations between energy and intensity. J. J. Markham. *Phys. Rev.*, **89**, 972–7 (*March* 1, 1953).

The effects of the recent change in the expression for the average acoustic energy are considered. In particular, its relation to the modified expression for the acoustic intensity is explored. Use is made of Airy's second-order solution of the field equations. The accepted average energy-intensity relation has to be reinterpreted in that only part of the energy travels with the velocity of sound. When a wave is propagated down a tube, it is headed by a region of higher density, while behind this region the average density is decreased. The calculation seems to explain the origin of the new term in the average energy density and to relate it to the radiation pressure. A.

534.231.3

3049. The acoustic wave guide. I. An apparatus for the measurement of acoustic impedance using plane waves and higher order mode waves in tubes. E. A. G. Shaw. *J. Acoust. Soc. Amer.*, **25**, 224–30 (*March*, 1953).

The (1 0) and (2 0) modes of acoustic waves in rectangular waveguides have been excited to the virtual exclusion of plane waves. The experimental techniques depend on the use of acoustic sources equivalent to two or more pistons with appropriate relative phases and amplitudes, precise adjustment of which is accomplished with the aid of an accurately located probe microphone. The standing wave pattern which arises when the waveguide is terminated by a partially absorbing surface may be used to determine the specific normal impedance of the surface, the value of which is characteristic of waves having a particular oblique angle of incidence and may be compared with normal incidence values obtained from plane wave measurements in the same waveguide and at the same frequency; the angle of oblique incidence may be varied by changing the frequency. The apparatus described operates in the 1–3 kc/s frequency region and the accuracy of impedance measurement with (1 0) and (2 0) waves is comparable with that attainable with the usual plane wave tube techniques. Equivalent angles of incidence at the absorbing surface up to 84° have been used. The principles underlying the design of the apparatus and some of the distinctive problems which arise with higher order mode waves are discussed. A.

534.231.3

3050. The acoustic wave guide. II. Some specific normal acoustic impedance measurements of typical porous surfaces with respect to normally and obliquely incident waves. E. A. G. Shaw. *J. Acoust. Soc. Amer.*, **25**, 231–5 (*March*, 1953).

The experimental techniques described in Pt I have been applied to the measurement of some acoustic properties of specimens of rockwood, hair-felt and acoustic tile, backed by a rigid wall. The more porous surfaces show substantial increases in resistance at oblique angles of incidence, an increase of nearly 100% at 80° incidence being observed in one case; smaller changes in reactance also occur. The absorption coefficients corresponding to impedance measurements at oblique incidence are compared with those "predicted" from normal incidence impedance measurements and significant differences are found. The measurement of surfaces having structure of finite dimensions is discussed with particular reference to an acoustic tile specimen, the impedance of which varies only slightly with angle of incidence. In some cases slight scattering of acoustic energy from one mode to another provides evidence of lack of uniformity of impedance over the surface of the specimen. A.

534.231.3

3051. The analogous acoustical impedance for discontinuities and constrictions of circular cross section. F. C. Karal. *J. Acoust. Soc. Amer.*, **25**, 327–39 (*March*, 1953).

The impedance introduced by an abrupt change of circular cross-section of a tube has been examined. It is shown that in the case of an ideal viscousless fluid the effect of the discontinuity is to introduce an inductance in series with the acoustical transmission system. The discontinuity inductance has been determined as a function of the ratio of the tube radii and has been plotted for different values of this ratio. The problem of a small tube or constriction inserted between two larger tubes has also been treated. It is shown that the constriction inductance is equal to the sum of the discontinuity inductances of each end taken separately to a very good approximation. The constriction inductance can be considered as a correction term to be added to the analogous acoustical inductance of the tube and can be interpreted physically as an increase in the equivalent length of the tube. A.

534.232

3052. The motional impedance of simple sources in an isotropic solid. H. Pursey. *Brit. J. appl. Phys.*, **4**, 12–19 (*Jan.*, 1953).

Analyses the motional impedance of sources of simple geometrical shapes which are either dilating or oscillating in an isotropic solid medium of infinite extent. The equation of wave propagation in an isotropic solid is expressed in cylindrical and spherical polar co-ordinates, assuming that in the cylindrical co-ordinate case there is no motion or variation along the cylinder axis (or in other words the problem is two-dimensional), while in the case of spherical co-ordinates no motion or variation takes place around lines of latitude, the direction of oscillation being regarded as the polar axis. In the case of dilating sources the problem is further simplified, as all movement and variation takes place along radial lines, and an equation can be derived relating the particle displacement and the radial distance from the source. A solution is found which satisfies the boundary conditions on the surface of the source, and which converges to a radiated wave of the form $e^{ik_1 r}/r$ for large values of r, where k_1 is the wavelength constant for compressional waves in the surrounding medium. In the case of oscillating sources the wave equation separates into two independent equations, one in $\nabla \cdot \bar{u}$ and the other in $|\nabla \times \bar{u}|$, the latter being a scalar quantity equal in magnitude to the vector $\nabla \times \bar{u}$. Solutions are obtained which converge at infinity as $e^{ik_1 r}/r$ for $\nabla \cdot \bar{u}$ and as $e^{ik_2 r}/r$ for $|\nabla \times \bar{u}|$, where k_1 is as before the compressional wavelength constant and k_2 the shear wavelength constant for the medium. The arbitrary constants are then adjusted to fit the boundary condition on the surface of the source. The total force on the source in the direction of motion is then calculated in each case from the generalized Hooke's law equations relating stress to strain, and hence the motional impedance is obtained by dividing force by velocity of source. Values of motional impedance per unit source area are plotted on an Argand diagram for several values of Poissons' ratio of the surrounding medium, showing the variation of impedance with source size, the latter quantity being expressed in units of $1/2\pi$ times the length of a compressional wave. This work is intended as a first step towards the analysis of the more complex sources which are encountered in practice, for example, a piston source on the free surface of a semi-infinite medium. A.

534.232

3053. Transient loading of a baffled piston. J. W. Miles. *J. Acoust. Soc. Amer.*, **25**, 200–3 (*March*, 1953).

The force-time history required to produce a step in the velocity of a circular piston mounted in an infinite baffle is determined with the aid of the Laplace transform. Working from this result, the inverse problem of the velocity response to a step force is calculated approximately. These two results suffice to treat arbitrary distributions of applied force or velocity by Duhamel superposition. The application of the results to a loud-speaker model shows that a system designed for critical damping on the "steady state" approximation for the air loading will actually be slightly overdamped in its initial motion, but that the characteristic time during which the design assumption is inadequate is of the order of 10^{-3} sec. A.

534.232

3054. Transient loading of a baffled strip. J. W. Miles. *J. Acoust. Soc. Amer.*, **25**, 204–5 (*March*, 1953).

The force-time history required to produce a unit step in the velocity of a two-dimensional plate mounted in an infinite baffle is determined and applied to more general velocity variations by Duhamel superposition. A.

534.232

3055. Transducers for producing ultrasonic waves. O. MATTIAT. *J. Acoust. Soc. Amer.*, **25**, 291–4 (*March*, 1953).

After a short description of mechanical transducers such as the siren in air and the Pohlman whistle in liquids, some fundamentals of electromechanical transducers using electric and magnetic fields are given, and magnetostrictive and piezoelectric transducers available for the irradiation of liquids are mentioned. In the second part transducers made of barium titanate ("ceramic transducers") are described. Polycrystalline ceramic material can be shaped and thereafter polarized in such a way as to produce convergent waves, with the possibility of focusing ultrasonic energy and thus creating zones of extremely high ultrasonic intensities. Electrical and acoustic data on spherical ceramic transducers are given. Fair agreement is found between O'Neil's theory of spherical transducers and measurements of the pressure distribution in a sound field along the central axis in front of the transducer. The diagram of motional impedance for a 400 kc/s spherical bowl and power limitations of ceramic transducers are discussed. Finally, a tubular ceramic transducer is described which seems to offer good possibilities for efficient treatment of large liquid volumes in a continuous flow process. A.

534.232

3056. Broad band directional barium titanate transducers. L. CAMP. *J. Acoust. Soc. Amer.*, **25**, 297–301 (*March*, 1953).

Transducers were constructed using thin-walled barium titanate tubes cut in short lengths. The outside walls of the tubes were covered with pressure relief material. Radial motion of the tubes developed motion along their axes in an enclosed fluid medium. If one end of the tube was closed by a heavy metal block, the tube became the equivalent of a quarter wave piston, the open end being a vibrating surface moving parallel to the axis of the tube. Various mosaic patterns were formed of these tubes to give directional transducers. Their operating characteristics were quite dependent on the kind of fluid enclosed by the tube. A.

534.232 : 517.522.3

3057. Approximate formula for the radiation resistance of a piston set in an infinite wall. E. M. J. HERREY. Letter in *J. Acoust. Soc. Amer.*, **25**, 154–5 (*Jan.*, 1953).

The piston is replaced by a pulsating sphere of the same velocity amplitude and surface area, and the wall by a similar sphere, giving the approximate formula, accurate to 8% for $ka < 2{\cdot}5$, $R = 2\pi a^2\rho c(ka)^2/[4 + (ka)^2]$, where a is the radius of the piston. This leads to the approximate formula for the Bessel function $J_1 : J_1(x) = \frac{1}{2}x(x^2 - 16)/(x^2 + 16)$, useful for $0 < x < 5$. G. L. WILSON

534.232 : 537.228.1

3058. A temperature invariant impedance point in the frequency response of circular barium titanate transducers. T. F. HUETER. Letter in *J. Acoust. Soc. Amer.*, **25**, 152 (*Jan.*, 1953).

At one particular frequency the mechanically derived part of the electrical input impedance is found to be independent of temperature. G. L. WILSON

534.232 : 621.317.39 : 621.395.623.7

3059. Direct measurement of the efficiency of loudspeakers by use of a reverberation room. H. C. HARDY, H. H. HALL AND L. G. RAMER. *Trans Inst. Radio Engrs Prof. Group on Audio, No.* 10, 14–24 (*Nov.–Dec.*, 1952).

If a loudspeaker has an axis of symmetry, its total radiated power, and therefore its efficiency, is computed by calculations from free-field data taken at various angles. The objections to this method are: (1) the calculations are very tedious; (2) loudspeakers as used in typical baffles do not have an axis of symmetry; and (3) elimination of phase effects requires measurements at a comparatively large distance outdoors or in a large anechoic room. The problem can be more directly approached by integrating the total power output in a large reverberation room. Data are presented on the results of such measurements. When a loudspeaker has been given a primary calibration by such a measurement, it may be used as a secondary standard in a smaller reverberant space, for example, in the manufacturer's laboratory. A.

534.232 : 621.395.623.7

3060. An investigation of the air chamber of horn type loudspeakers. B. H. SMITH. *J. Acoust. Soc. Amer.*, **25**, 305–12 (*March*, 1953).

The air chamber is treated as a boundary value problem which results in the solution of the wave equation for the general case in which the horn throat enters the air chamber in any circumferentially symmetrical manner. The following specific cases are analysed: (1) the case in which the horn throat enters the air chamber by means of a single orifice, (2) the throat enters the air chamber by means of a single annulus of radius r and width w, and (3) the throat enters the air chamber in "m" annuluses of radii $r_1 \ldots r_m$ and widths $w_1 \ldots w_m$. The analysis reveals that the radial perturbation caused by the throat excites higher order modes. At the resonant frequencies of these modes the throat pressure becomes zero and the loudspeaker does not radiate. By suitable choice of annulus radii and widths the first "m" modes may be suppressed and the corresponding nulls in the output pressure eliminated. A.

534.24

3061. Interference between two ultrasonic beams reflected by a plane wall. Conduction of waves. F. CANAC. *C.R. Acad. Sci.* [*Paris*] **236**, 360–2 (*Jan.* 26, 1953) *In French.*

Employing methods of optical interferometry such as those of Lucas and Biquard, Debye and Sears, and Brouillon, the author has observed the phenomena when high frequency ($\lambda = 1{\cdot}4$ cm) sound waves are reflected from a plane surface. Observations were made both by stroboscopic and by continuous illumination. In the former case the interference between incident and reflected waves forms a lozenge type pattern, whilst in the latter case the pattern consists of dark and bright lines. If a second, smaller, reflector is placed near and parallel to the first there is evidence that the sound proceeds in the

channel thus formed. There is evidence that the velocity of propagation exceeds that of sound in free space. A. B. WOOD

534.26

3062. Diffraction of sound waves by a circular aperture. G. Bekefi. *J. Acoust. Soc. Amer.*, **25**, 205–11 (*March*, 1953).

Diffraction of an acoustic wave by an aperture in a plane reflecting screen has been investigated experimentally at a wavelength of about 3 cm. The pressure amplitude distribution within a circular aperture illuminated by a plane, progressive sound wave exhibits oscillations which do not conform to theoretical requirements. A possible explanation for the disagreement is offered. Diffraction measurements made in the near-field of the circular hole were found to be in fair agreement with the Fresnel–Kirchhoff theory. A modified theoretical expression, valid for apertures large as compared to the wavelength, is also presented. It is concluded that this theory is capable of predicting the diffraction effects to a greater degree of accuracy and over a larger region of space than Kirchhoff's classical formula. A.

534.321.9

3063. A high-frequency reciprocating drill. E. A. Neppiras. *J. sci. Instrum.*, **30**, 72–4 (*March*, 1953).

An instrument is described which uses intense mechanical vibrations at ultrasonic frequency for drilling and cutting brittle materials. To generate the vibrations, a high Q magnetostriction transducer is used in conjunction with a suitable step-up velocity transformer. The instrument is essentially a high-speed reciprocating drill which enables complicated machining operations to be performed rapidly and easily in most brittle materials. A.

534.321.9 : 621.395

3064. A contribution to the problem of using ultrasonics for telephone transmission. L. Pimonow. *Ann. Télécomm.*, **8**, 28–30 (*Jan.*, 1953) *In French.*

Refers to the use of ultrasonic vibrations as carriers for telephone signals. Some experimental results are given and an installation is described which has been designed for UNESCO in order to enable translations of speeches to be transmitted in several languages simultaneously. V. G. WELSBY (R)

534.321.9 : 678 : 620.179.16

3065. Ultrasonic techniques in the rubber industry. R. G. Patton and P. Hatfield. *Electronic Engng*, **24**, 522–5 (*Nov.*, 1952).

A technique is described for detecting flaws in tyres. A 50 kc/s beam is directed from a transmitting crystal inside the tyre to a number of receiving crystals outside the tyre, which is immersed in water and slowly rotated. Fault areas cause the signal from one of the receivers to fall, enabling the fault to be located. For fault areas below $\frac{1}{8}$ in. $\times \frac{3}{8}$ in., a frequency of 180 kc/s is used. A technique is also described for measuring the thickness of rubber when only one surface is available, and the use of high-power ultrasonics for de-gassing liquids, dispersion of solid particles, plating of Al and internal heating of solids is mentioned. G. F. HODSMAN (R)

534.39 : 537.36

3066. The acousto-electric effect. R. H. Parmenter. *Phys. Rev.*, **89**, 990–8 (*March* 1, 1953).

A new effect, the acousto-electric effect, is predicted on the basis of theoretical calculations. This effect deals with the generation of an electric current by a travelling longitudinal acoustic wave. The time-average of the generated current is found to depend on the sound power but not on the frequency of the acoustic wave. Illustrative calculations on a metal (Na) and a semiconductor (n-type Ge) indicate that the effect should be experimentally measurable. An interesting analogy with the thermoelectric effect is pointed out. A.

534.614

3067. Contribution to ultrasonic measuring techniques. A. Giacomini. *Ricerca sci.*, **23**, 75–80 (*Jan.*, 1953) *In Italian.*

A description is given of a new method for measuring ultrasonic velocity (longitudinal waves) in solids. The method is based on the comparison between the unknown velocity and the velocity in water. Pulse technique is being used and the equipment does not require any special apparatus. A.

534.62

3068. A variation of the radiation pressure method of measuring sound absorption in liquids. F. L. McNamara and R. T. Beyer. *J. Acoust. Soc. Amer.*, **25**, 259–62 (*March*, 1953).

An apparatus is described which may be used to measure the ultrasonic absorption coefficient in liquids. The transducer is 100% modulated at an audiofrequency. This produces the same frequency variation in the radiation pressure. A condenser microphone is used to detect these low frequency pressure changes. The apparatus has been tested in water over the frequency range 9–27 Mc/s and possesses an accuracy which is comparable to that of pulse and optical methods. A.

534.83

3069. Apparatus and procedures for predicting ventilation system noise. L. L. Beranek, J. L. Reynolds and K. E. Wilson. *J. Acoust. Soc. Amer.*, **25**, 313–21 (*March*, 1953).

A method has been developed for measuring the acoustic power output in watts and the frequency spectra of ventilating fans operating into ducts. Both the inlet and the exhaust noise are determined as a function of back-pressure. The fan is ideally connected to a circular section of duct about equal in dia. to the fan dia. and 5 to 10 dia. in length; 3 to 6 dia. from the input end of this duct an air straightener is located. The acoustic measurements are made with a condenser microphone enclosed in a wind screen located 4 to 8 dia. from the inlet. The outlet end of the duct couples through an exponential connector to an anechoic wedge structure 2 ft square. This is backed by a plenum chamber containing an array of holes that can be progressively closed to produce increased back-pressure. Sound pressure level measurements are made in frequency bands and converted to acoustic watts per band. The inlet

noise is measured over a hemispherical surface outdoors to obtain the directivity pattern and the acoustic power for each frequency band. Engineering formulae and charts for applying the data to prediction of the noise produced in rooms are presented, including the effects of room characteristics, duct losses and the distance from the ventilating grille in the room. Criteria for permissible noise levels in various types of rooms and auditoriums are presented. A.

534.83

3070. Noise of ventilating fans. C. F. Peistrup and J. E. Wesler. *J. Acoust. Soc. Amer.*, **25**, 322–6 (*March*, 1953).

Using the apparatus described in the preceding abstract, measurements were made of the acoustic power in watts in 24 bands each $\frac{1}{3}$ octave wide for 3 vaneaxial-type and 2 centrifugal-type fans of graded sizes. Formulae were derived empirically, enabling the computation of the over-all acoustic power of the noise for the exhaust end of a fan where the input power, the number of blades, blade-tip speed and other design characteristics are known. The directivity pattern and acoustic power generated for each of the 24 bands was also measured at the inlet with the fan mounted in one end of a long duct outdoors. The effects of back pressure were also determined. As a second stage of this investigation, the acoustical characteristics of unlined ducts were studied. The attenuation effects of one and two, 90° unlined bends placed in the 10 in. by 12 in. duct system were determined. The greatest amount of attenuation was found in those frequency bands that contained the frequencies for which the width of the duct, in the direction of the bend, was 0·5 wavelength and 1·5 wavelength. A.

534.833

3071. Approximate calculation of the efficiency of acoustic treatment of aircraft cabins. M. Kobrynski. *Ann. Télécomm.*, **8**, 31–6 (*Jan.*, 1953) *In French.*

The author refers to "the index of intelligibility of speech" as a criterion of acoustic comfort in an aeroplane cabin, when passengers can carry on conversation in the presence of masking noise. Calculations are made of the reflecting and absorbing properties of the cabin walls, which must *a priori* be of light construction. He first considers the theory of a closed room "surrounded by a homogeneous and isotropic sound field." The conclusions are then applied to the practical cases of the cabins of aeroplanes. The theoretical results appear to be in good agreement with experimental measurements in actual aircraft. A. B. WOOD

534.836

3072. Noise in private cars. J. R. Bristow. *Automobile Div. Proc. Instn Mech. Engrs, No.* 1, 9–22 (1951–52).

The reasons for making objective analyses of the noise in vehicles, how such analyses are carried out and their subjective interpretation are discussed. Results of the objective comparison, by octave-band analysis, of the "noisiness" of three vehicles are given and critically discussed with reference to the subjective "noisiness" of the three cars. Wind noise in two cars is also briefly referred to. It is suggested that detailed objective octave-band analyses of the type outlined, carried out over a speed range are capable of correct subjective interpretation and define adequately, and permanently, the "noisiness" of a vehicle. A.

534.837

3073. The measurement and interpretation of machinery noise with special reference to oil engines. C. H. Bradbury. *Proc. Instn Mech. Engrs B*, **1**, *No.* 1, 1–8 (1952).

This paper attempts to deal with the problem of machinery noise from the engineer's viewpoint and particular consideration is given to oil-engine noise. After a brief consideration of basic acoustical principles, an examination is made of commercial methods of noise measurement, illustrated by examples from various types of machinery. A suggested interpretation of these examples is then considered, from both the objective and subjective viewpoint, and an attempt is made to correlate diagrams obtained by measurement and known sources of engine noise. Methods of noise reduction are examined. Brief reference is made to the acoustic hood and the possibilities of its use in residential districts. The paper is restricted to an examination of airborne noise. Vibration transmitted through the ground and its reappearance as noise away from the machinery is not considered. A.

534.842

3074. The acoustics of the Royal Festival Hall, London. P. H. Parkin, W. A. Allen, H. J. Purkis and W. E. Scholes. *J. Acoust. Soc. Amer.*, **25**, 246–59 (*March*, 1953).

Describes in some detail the acoustical design, the test concerts held in it before the opening, the objective measurements made in it, and the comments about its acoustics that have been made during the first eighteen months since its opening. These comments show that the "definition" is excellent, but that for some types of music more "fullness of tone" would be desirable. It is concluded that the reverberation time is the only objective measurement which, at the present stage of development, is of practical use. Its value in the Royal Festival Hall when full is 1·5 sec (at 500 c/s), which is 0·2 sec shorter than the optimum value given by Knudsen and Harris for a hall of this size. It seems probable that the "fullness" would be adequate if the reverberation time could be lengthened to 1·7 sec or somewhat longer. A.

534.88

3075. Sound ranging in a medium having an unknown constant phase velocity. W. Schriever. *Geophysics*, **17**, 915–23 (*Oct.*, 1952).

A method for the sound ranging of explosions is described, in which the direction-angle of the explosion is given in terms of the ratio of the differences in the arrival times at two pairs of microphones, geophones, or hydrophones. It is unnecessary to know either the phase-velocity in the intervening medium or the absolute values of the time differences. However, the paths and the phase-velocities must be such that the time differences are the same as they

would be for a wave-front travelling from explosion to the microphones at some constant velocity. A rapid graphical method for determining the location of the explosion is described. The precision of the determinations is discussed. Applications of the method to the scoring of bomb hits on bombing practice areas are suggested. The effect of the motion of the medium is considered. A.

534.88

3076. Echo ranging with audiofrequencies. G. BRADLEY. *Amer. J. Phys.*, **21**, 159–61 (*March*, 1953).

The mathematical form of a propagating wave is discussed, and it is pointed out that it may be misleading to emphasize the harmonic form of a wave in the general physics course. A demonstration piece utilizing a sound pulse is described. The demonstration piece is suitable to illustrate (*a*) the speed of a sound, (*b*) reflection methods of ranging, and (*c*) reverberations in rooms. A.

OPTICS . RADIATION . SPECTRA 535

535.14 : 538.566

On the propagation of white light in a vacuum. *See Abstr.* 3451

535.214.6

3077. Comparison of the luminous energies present at the two faces in the interior of a lamina, illuminated at normal incidence by a parallel pencil. P. TAUZIN. *C.R. Acad. Sci.* [*Paris*] **235**, 1632–4 (*Dec.* 22, 1952) *In French.*

It is shown theoretically that if a parallel pencil of radiation falls on a parallel sided absorbing plate, and allowance is made for the effects of multiple reflections, there is an excess of energy at the emergent face if the absorption coeff. is less than a certain value. It is suggested that this is the cause of the negative photophoresis shown by small metal particles. N. CORCORAN

535.223

3078. On the precision of optical methods for the determination of the velocity of light. E. BERGSTRAND. "*Maintenance of standards*" *symposium*, 75–88 [see Abstr. 2972 (1953)].

A critical review and comparison of the methods and results of the main optical experiments since 1926, including detailed reference to the author's recent (1950) work for which the high value 299 793·1 ± 0·2 km/s was obtained. The opinion is expressed that this value is not incompatible with the earlier ones, when their limits of error are taken into account. S. WEINTROUB

535.23 : 530.12

3079. Radiation sphere in Einstein universe. A. K. REYCHAUDHURI. *Bull. Calcutta Math. Soc.*, **44**, 31–6 (*March*, 1952).

It is shown that nonhomogeneity in the structure of the Einstein universe is compatible with equilibrium, provided continuity in the distribution of the energy density is sacrificed. The universe may contain spherical pockets of pure blackbody radiation in equilibrium with the universe. The investigation involves the integration of the field equations and a study of the energy-density distribution in a spherical cavity. L. S. GODDARD

535.241

3080. The establishment of the photometric scale at the National Physical Laboratory. J. W. T. WALSH. "*Maintenance of standards*" *symposium*, 63–8 [see Abstr. 2972 (1953)].

Describes how the various standards used at the N.P.L. are derived from the primary standard of light and how the colour steps involved are bridged in accordance with the international values of the luminous efficiency of radiation throughout the visible spectrum. The method of obtaining flux standards from luminous intensity standards is described. The estimated accuracy of the derived standards is 0·25% for luminous intensity and 0·5 to 1% for luminous flux. J. W. T. WALSH

535.241

3081. Co-ordination of the photometric units at the Bureau International des Poids et Mesures. J. TERRIEN. "*Maintenance of standards*" *symposium*, 68–74 [see Abstr. 2972 (1953)].

The photometric scales maintained at the various national laboratories are compared by means of sets of lamps sent to the B.I.P.M. periodically. These sets are measured respectively for luminous intensity at the colour temperatures 2042° and 2353° K and for luminous flux at 2353° and 2788° K. The paper describes the intercomparisons carried out so far and the apparatus used for the work. Estimates of accuracy are made and sources of error are discussed. J. W. T. WALSH

535.245 : 628.9

3082. Theory of the photic field. P. MOON AND D. E. SPENCER. *J. Franklin Inst.*, **255**, 33–51 (*Jan.*, 1953).

Considers the application of field theory to the calculation of the illumination due to extended sources, and shows that it is often possible to obtain results very simply without the troublesome integrations needed when using classical methods. Theorems are stated regarding the conditions for the existence of a potential, a quasipotential and a vector potential in the light field; methods of solution are outlined and boundary conditions are formulated. J. W. T. WALSH (R)

535.247.4 : 621.314.6

3083. Harmonic synchronous rectification in double-beam photometry. J. J. OBERLY. *Rev. sci. Instrum.*, **24**, 125–6 (*Feb.*, 1953).

In synchronous rectification the rectifier is adjusted in phase with its signal to produce a maximum d.c. output. The properties of linearity and phase discrimination of synchronous rectifiers have been widely used in photometry and other electronic applications. A third property—discrimination against harmonically related frequencies—can be used to improve the separation of signals heretofore accomplished by phase discrimination. The principle is analysed with particular reference to double-beam

photometry, and data obtained by modifying an existing double-beam photometer are reported. Harmonic synchronous rectification should be especially useful when only very little "cross-talk" can be tolerated or when the relative phase of signals and rectifiers cannot be maintained conveniently with the accuracy demanded by the single-frequency system.

A.

535.313

3084. Geometric performance of a Fresnel mirror. L. RONCHI AND G. TORALDO DI FRANCIA. *Atti Fond. Ronchi*, **7**, 352–64 (*Nov.–Dec.*, 1952) *In Italian.*

The off-axis aberrations of a Fresnel spherical mirror corrected for infinity are calculated. By placing the focus at the centre of the sphere it is possible to eliminate the sagittal coma. As far as the simplifying assumption of infinitely thin zones is valid, the resulting image is much better than that given by a conventional concave mirror.

A.

535.317

3085. On the aberrations of Fresnel lenses of plastic material. I. L. RONCHI AND G. TORALDO DI FRANCIA. *Atti. Fond. Ronchi*, **7**, 145–60 (*May–June*, 1952) *In Italian.*

The behaviour of a plastic Fresnel lens is investigated from the point of view of geometrical optics, under the assumption of an ideal condition of continuity. The authors have calculated the spherical aberration up to the fifth order and spherochromatic aberration, coma, astigmatism of the third order. In the case considered in the present paper the lens is perfectly corrected for spherical aberration for an object at infinity, when the plane surface of the lens is turned toward the object.

A.

535.317

3086. On the aberrations of Fresnel lenses of plastic material. II. L. RONCHI. *Atti Fond. Ronchi*, **7**, 231–43 (*July–Aug.*, 1952) *In Italian.*

The aberrations of a Fresnel lens corrected for spherical aberration for an object at infinity on the side of the rugged surface of the lens are studied. A comparison is made with the aberrations of Pt. I. It is found that in the case here considered, some of the aberrations are identical, some others are considerably less.

535.317 : 535.42

3087. Diffraction images in systems with an annular aperture. E. H. LINFOOT AND E. WOLF. *Proc. Phys. Soc.* [*London*] *B*, **66**, 145–9 (*Feb.*, 1953).

Concerned with the effects of central obstruction of the aperture on the three-dimensional light distribution near the focus of an aberration-free optical system. Diagrams are given of the isophotes (lines of equal light intensity) in two selected special cases and are compared with the corresponding diagram for an unobstructed aperture. It appears that when the central obstruction is large the bright central nucleus of the three-dimensional image becomes longer and narrower, so that focal depth and resolving power are both increased. A central obstruction of ratio 0·25, on the other hand, is found to have practically no effect on the size and shape of the bright nucleus.

A.

535.318

3088. A high-precision method for measuring the distortion of photographic objectives. A. FIORENTINI AND G. TORALDO DI FRANCIA. *Atti Fond. Ronchi*, **7**, 161–76 (*May–June*, 1952) *In Italian.*

The method utilizes the combination fringes obtained by suitably superimposing two identical photographs of an object grating. The results of some actual measurements made by the authors are illustrated.

A.

535.32 : 532.7

Experiments on the internal dispersion of optical waves. *See Abstr.* 3002

535.32 : 534.22 : 532.7

Molecular motion in fluids and internal dispersion and absorption of elastic and optical waves. *See Abstr.* 3001

535.322.4

3089. A new highly sensitive differential refractometer. G. V. SCHULZ, O. BODMANN AND H.-J. CANTOW. *Z. Naturforsch.*, **7a**, 760–3 (*Nov.*, 1952) *In German.*

Small changes of refractive index can be measured with an accuracy of 3×10^{-7}. The system uses a photometric measurement of the position of a slit image. A double prism gives two slit images whose separation is a function of the index difference. Details of the instrument, which can be used in the invisible regions of the spectrum, are given.

R. W. FISH

535.323

3090. Index of refraction of magnesium oxide. R. E. STEPHENS AND I. H. MALITSON. *J. Res. Nat. Bur. Stand.*, **49**, 249–52 (*Oct.*, 1952).

The index of refraction of MgO crystal has been measured for wavelengths from 0·36 to 5·35 μ. In the visible region, measurements were made at three temperatures, close to 20°, 30° and 40°C. Thermal coefficients were computed for this range of temperatures for nine wavelengths.

A.

535.323

3091. Refractivity of potassium bromide for visible wavelengths. R. J. SPINDLER AND W. S. RODNEY. *J. Res. Nat. Bur. Stand.*, **49**, 253–62 (*Oct.*, 1952).

Values of the index of refraction of KBr were determined independently on two high-precision spectrometers by the method of minimum deviation for 11 spectral lines at temperatures near 17°, 24° and 27° C. The instruments are described, and the methods used in obtaining results valid in the sixth decimal place of index are discussed. Temperature coefficients of index were determined, and a small linear variation was found with respect to wavelength. With the values of dn/dt so obtained, the experimental data were reduced to a common temperature, averaged, and a four-constant Ketteler–Helmholtz dispersion equation fitted to the data and adjusted by least squares. The refractive indices of KBr for the particular prism used are intermediate between the values reported by Harting (1943) and Forrest (1942). Reduced to 23° C for comparison, the results for sodium light are: Harting, 1·55983; National Bureau of Standards, 1·55978; and Forrest, 1·55971.

Another prism measured at N.B.S. yielded 1·55983, and an obviously defective prism gave 1·55889. Small differences in dispersion were also detected. A.

535.323 : 535.345

3092. On a method for measurements of optical constants by reflection. F. Abelès. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 996 (*Dec.*, 1952).

Approximate formulae are given for the determination of optical constants from the experimental data obtained in the method suggested by Avery [see Abstr. 6371 (1952)]. D. G. AVERY

535.323 : 535.345

3093. The optical constants of lead sulphide, lead selenide and lead telluride in the 0·5–3 μ region of the spectrum. D. G. Avery. *Proc. Phys. Soc.* [*London*] *B*, **66**, 134–40 (*Feb.*, 1953).

Measurements have been made of the refractive and absorption indices n, k of PbS, PbSe and PbTe at wavelengths between 0·5 and 3 μ, using a reflection method. The values found for n at 3 μ are for PbS 4·10, PbSe 4·59 and for PbTe 5·35. The absorption spectra found agree with earlier work, and it has been shown that for PbS a variation of 200 : 1 in the concentration of impurity centres in specimens produced no change in the magnitude of the absorption. A.

535.323 : 535.345

3094. Inter-relation between optical constants for lead telluride and silicon. T. S. Moss. *Proc. Phys. Soc.* [*London*] *B*, **66**, 141–4 (*Feb.*, 1953).

There exists a general principle that in any oscillatory or frequency responsive system the real and imaginary components of the impedance are interdependent. Applied to the optical properties of materials this principle means that the real and imaginary parts of the dielectric constant are interdependent. Sufficient information is now available on lead telluride (preceding abstract) and silicon for this principle to be used to calculate the refractive indices from the absorption data. The values obtained show good agreement with the experimental values. Estimates of the effect of temperature show that for PbTe the refractive index should increase on cooling, while for Si it should decrease. A.

535.33.03 : 531.552

3095. Time-resolved spectroscopy of ultraspeed pellet luminosity. W. A. Allen and E. B. Mayfield. *J. appl. Phys.*, **24**, 131–3 (*Feb.*, 1953).

Improved optical instrumentation has resulted in high time-resolution spectrograms of the luminosity associated with ultraspeed Al pellets. These data indicate that in many cases the light is emitted in two phases: (1) the ballistic, or air shock, characterized by atomic metal lines and a strong continuum; (2) AlO bands that appear about 150 μsec after the metal is ablated from the pellet. See also Abstr. 4311 (1952). A.

535.33.03 : 537.525.4

3096. Emission characteristics of vacuum spark discharges. J. C. Wahr, W. W. McCormick and R. A. Sawyer. *J. Opt. Soc. Amer.*, **43**, 151–6 (*March*, 1953).

A study of the total radiation in the visible region from vacuum spark discharges between electrodes of Al, Mg, Cu and C has been made. With a capacitance of 21·6 μF charged to potentials up to 20 kV and inductance variable from 2·4 to 45 μH peak currents up to 65 000 A were obtained. Oscilloscope traces of the output voltage from a photocell show that for the underdamped discharge the light output closely follows the current oscillations, dropping to zero between current cycles. The maximum light intensity in a single spark train varies as the third to the seventh power of the peak discharge current, or with the 3/2 to the 7/2 power of the discharge energy, depending on the electrode material and the inductance. For a given electrode material, the exponent increases as the inductance is decreased, while at constant current the maximum light intensity decreases slightly as the inductance is decreased. With Al electrodes ranging from $\frac{1}{2}$ to $\frac{1}{16}$ in. in dia., the maximum light intensity varies inversely with the electrode cross-sectional area. Estimates of current densities as high as 100 000 A per cm² in a 10 000 A Al spark were made from measurements of the anode spots on the electrodes. Bursts of luminous vapour from the anode, apparently not a part of the current-carrying column, appear to constitute the principal source of light in the critically damped Al spark. A.

535.33.03 : 537.525.8

3097. Spectroscopic study of caesium discharges in a magnetic field. L. W. Davies. *Proc. Phys. Soc.* [*London*] *B*, **66**, 33–40 (*Jan.*, 1953).

From measurements of the intensity distribution in the recombination spectrum, the relative densities of the electrons and their velocity distribution in the positive column of a Cs discharge are determined in the presence of a longitudinal magnetic field. In r.f. discharges, the magnetic field is found to increase the electron temperature, contrary to expectation. In d.c. discharges, the effect of the field is found to depend on the direction of the current; this effect is ascribed to gradients in the gas pressure set up by the discharge current. A.

535.33.07

3098. An adjustable slit for a vacuum spectrograph. M. T. Christensen. *J. sci. Instrum.*, **30**, 70–1 (*March*, 1953).

A symmetrically opening slit is described. It follows the principles of a design given by Roemer and Oetjen, but has modifications to suit its application to vacuum spectrographs, to permit the choice of various ranges of widths and to avoid certain workshop operations. A series of tests shows that such a slit is both reproducible and symmetrical in opening and has a linear relation between width and setting which is of remarkable accuracy. A.

535.33.07 : 535.42

3099. The influence of the phenomenon of diffraction at the slit of a spectrograph on the intensity of the spectral lines. B. Righini-Crino. *Atti Fond. Ronchi*, **7**, 221–30 (*July–Aug.*, 1952) *In Italian.*

See Abstr. 8617 (1951). The amounts of energy reaching the focal plane of a spectrograph have been measured as a function of the width of the slit. The

results agree fairly well with the values reckoned according to the diffraction theory. A.

535.33.07–15

3100. A simple high-speed spectrometer for the infra-red region. D. A. H. Brown and V. Roberts. *J. sci. Instrum.*, **30**, 5–8 (*Jan.*, 1953).

A single prism spectrometer is described which uses a photoconductive detector of short response time to display spectra in the near i.r. region at a high repetition rate on a cathode-ray tube. The performance of the instrument is briefly discussed and illustrated by photographs of typical spectra. Using a lead-telluride cell, the long wave limit is about 5·5 μ. The instrument could be made to work at longer wavelengths by using a bolometer or pneumatic detector, but at a sacrifice of speed or resolution, and in the visible and u.v. by using a photoemissive cell or other suitable detector. A.

535.33.07–15 : 621.395.645

3101. An optical system and thermopile amplifier for double-beam recording of infra-red spectra. J. L. Hales. *J. sci. Instrum.*, **30**, 52–7 (*Feb.*, 1953).

A general review is made of double-beam systems in absorption spectroscopy. Apparatus is described in which the two beams of radiation fall alternately on to a fast thermopile, the latter being in the primary circuit of a step-up transformer designed to work at low frequencies. The output goes to a low-noise wide-band amplifier capable of a maximum overall voltage gain exceeding 10^9. The amplified signals from the two beams are separated and rectified by a simple mechanical switch on the radiation interrupter shaft, thus making the amplifier selective for frequency and phase, and enabling response time to be varied between 1 and 100 sec. Finally, the ratio of the outputs is measured on a potentiometer recorder. The reference beam output is used to regulate a slit monitor, so maintaining a constant reference energy level on the thermopile through the whole spectral range. The performance of the equipment is illustrated. A.

535.33.07–32

3102. Spectrophotometric measurements in the vacuum ultra-violet using photomultipliers. J. H. Bolton and S. E. Williams. *Brit. J. appl. Phys.*, **4**, 6–11 (*Jan.*, 1953).

The spectrograph and light sources, namely, capillary arc and pulsed discharge, used in experiments with fluorescence sensitized photomultipliers, are described. Insufficient signal-to-noise ratio was obtained from a 921A multiplier at 1200 Å with reasonably narrow slits. A 5060 multiplier gave a good response when the spectrograph slit was 0·048 mm (0·83 Å equivalent) and photomultiplier slit 0·025 mm (0·45 Å), allowing a resolving power of about 2000 at 1200 Å. The observed profile of 1215·6 Å showed that distortion and focusing errors were too small to prevent measurement of true maximum intensities. Apiezon B oil, L grease and zinc orthosilicate on L grease were found to give the best response as fluorescing agents. Some observations were made on the effect of water vapour passing through the discharge into the spectrograph. A.

535.331

3103. A description of the arc and spark spectra of rhenium. W. F. Meggers. *J. Res. Nat. Bur. Stand.*, **49**, 187–216 (*Sept.*, 1952).

A more complete and accurate description of the atomic emission spectra was obtained by using solid metal electrodes of rhenium in conventional arcs or sparks, photographing the spectra with the aid of large spectrographs containing concave gratings, and measuring the wavelengths of spectral lines relative to secondary standards in the spectrum of iron. Relative intensities were carefully estimated for all lines, and the total widths of many broad lines were measured. Results are presented for approximately 6000 lines ranging in wavelength from 2000·47 Å in the ultraviolet to 11788·9 Å in the infrared. A comparison of the estimated intensities in arc and spark spectrograms provides a separation of the spectral lines arising from neutral rhenium atoms from those originating in ionized atoms. In this description the Re I spectrum is represented by about 4200 lines and the Re II spectrum by nearly 1800 lines. A.

535.338 : 537.228.5

3104. Theory of the Stark effect of asymmetric rotator with hyperfine structure. M. Mizushima. *J. chem. Phys.*, **21**, 539–41 (*March*, 1953).

The Stark effect of asymmetric rotator is calculated, including the effect of hyperfine structure, for weak and stronger field cases. The result includes the Stark effect of symmetric rotator and linear rotator as special cases. A.

535.338.332

3105. New measurements of the spectral intervals which separate the hyperfine components of the mercury line λ2537. R. Lennuier and J.-L. Cojan. *C.R. Acad. Sci.* [*Paris*] **235**, 1634–6 (*Dec.* 22, 1952) *In French.*

The emission and absorption spectra studied by a Fabry–Perot etalon give a structure rather different from that generally accepted. The separation of each line contributing to the five main hyperfine components is established. H. H. GREENWOOD

535.338.334 : 539.133

3106. Optical effective diameter in iodine vapour mixtures. W. Luck. Note in *Z. Naturforsch.*, **7a**, 823 (*Dec.*, 1952) *In German.*

See also Abstr. 7695 (1951). The line breadths of iodine lines are determined at 150°c from mixtures of iodine with various gases. The effective radius of excited iodine molecules is calculated from these data by use of the Lorentz collision theory. These values are compared with those found by gas kinetic methods. The ratios of optical and kinetic radii are listed. For mixtures with H_2 and He a low value is found: this is probably due to the fact that the value used for the exponent of repulsion is too high. Those solvents in which iodine dissolves with a brown colour show high values for the iodine radius.

A. J. TAYLOR

535.338.4

3107. The complex band spectrum of diatomic manganese chloride in the visible region. P. Tiruvenganna Rao. *Proc. Nat. Inst. Sci. India*, **18**, 481–6 (*Nov.–Dec.*, 1952).

The emission spectrum was excited in a heavy current discharge through the vapour and photographed in the visible region using a Fuess glass spectrograph. Two systems designated here as γ and γ' were obtained more extensively than those reported by Mesnage. The γ system occurring in the region λ4800–λ5100 has been interpreted on the basis of a $^5\pi$–$^7\Sigma$ transition involving terms of high multiplicity. The vibrational constants ω_e' and ω_e'' were approximately obtained as 370 cm^{-1} and 384 cm^{-1} respectively. Measurements of 22 bands occurring in four groups of the γ' system are given and a recurring wave-number interval of 384 cm^{-1} between some bands is also indicated. A.

535.338.4

3108. Π–$^5\Sigma$ electronic transition in cobalt chloride. V. G. Krishnamurty. *Indian J. Phys.*, **26**, 177–85 (*April*, 1952).

The band spectrum of the diatomic molecule CoCl has been obtained in emission using a heavy current discharge. The bands are slightly red degraded and occur in six groups extending from λ6000 to λ5350 Å. The bands are line like and are similar to the band systems obtained in the case of Mn and Cr halides. They are of complex structure and show an abnormal intensity distribution among the heads and are assigned to the transition $^5\Pi$–$^5\Sigma$, involving quintet electronic states. The vibrational constants obtained are $\omega_e = 412{\cdot}3$ and $\omega_e'' = 416{\cdot}0$. A.

535.338.4

3109. The complex band spectrum of nickel chloride (NiCl). V. G. Krishnamurty. *Indian J. Phys.*, **26**, 207–25 (*May*, 1952).

The band spectrum of the diatomic molecule NiCl extending from λ4900 to λ3800 Å has been obtained in emission using a heavy current discharge from a 2 kW, d.c. generator. The bands are line-like and are slightly degraded to the red. The bands within many of the sequences show abnormalities in intensity and present on the whole a complex appearance. This peculiar structure is ascribed to be due to high multiplicity terms being involved in the electronic transitions and an overlapping of several band systems. The bands have been analysed into 5 systems designated as *A*, *B*, *C*, *D* and *E*. The systems involve doublet and quartet terms. Systems *A*, *B* and perhaps *E* have a common lower state. The 0,0 sequence in system *C* presents double-headed bands of equal intensity. The system is assigned to a $^2\Sigma$–$^2\Sigma$ electronic transition, the band heads of which are represented by $\nu = 22\,749{\cdot}2 \pm 398{\cdot}9u' - 1{\cdot}03u'^2 - 421{\cdot}5u'' + 0{\cdot}51u''^2$. The vibrational formula for the bands of the *D* system (also assigned as a $^2\Sigma$–$^2\Sigma$ transition) is $\nu = 21\,920{\cdot}5 + 404{\cdot}4u' - 1{\cdot}16u'^2 - 422{\cdot}5u'' + 0{\cdot}25u''^2$. Of the observed three different lower states, one $^4\Sigma$ and two $^2\Sigma$'s, the ground state of the NiCl molecule is $^4\Sigma$. A.

535.338

3110. A band-system of radium chloride. A. Lagerqvist. *Ark. Fys.*, **6**, *Paper* 15, 141–2 (1952).

The vibrational analysis of a red-degraded syste of RaCl excited in a hollow-cathode discharge presented. The following constants (cm^{-1}) a derived:

State	ν_e	ω_e	$x_e\omega_e$
$C\,^2\Pi$	15 385·9	252·9	0·72
	14 782·1	253·8	0·71
$X\,^2\Sigma$	0	256·2	0·71

R. F. BARROW

535.338.

3111. Emission spectrum of undecomposed methylpyrrole. G. Milazzo. Letter in *J. chem Phys.*, **21**, 163–4 (*Jan.*, 1953).

A faint band-emission spectrum between th frequencies 34 800 and 41 500 cm^{-1} has been observe at a pressure of 1 mm. Results are briefly discussed G. I. W. LLEWELY

535.338.4 : 551.59

3112. Forbidden transitions in the spectra of dia tomic molecules. G. Herzberg. *Trans Roy. Soc Canada*, **46**, *Sect. III*, 1–22 (*June*, 1952).

The study of transitions in molecular atmospheri spectra which violate classical selection rules i reviewed with particular reference to results fo homonuclear molecules, e.g. H_2 and O_2. 4 references. D. R. BARBE

535.338.4–1

3113. The emission spectrum of OH from 1·4 t 1·7 μ. W. S. Benedict, E. K. Plyler and C. J. Humphreys. *J. chem. Phys.*, **21**, 398–402 (*March* 1953).

The first overtone region of OH has been measured in emission from an oxyacetylene flame in the region of 1·6 μ. The rotational structure in the *P* branch of the 2→0 band, from $K = 4$ through $K = 19$, o the 3→1 band, from $K = 4$ through $K = 15$, and o the 4→2 band, from $K = 4$ through $K = 10$, has been identified. For each K value there are four lines. These are resolved for values of $K > 7$. From the intensities of the lines, a vibration-rotation temperature has been determined. For the mixture of gases burned in this work with small flames, it was found that the "temperature" was 2600 ± 100°K. A

535.338.4–31

3114. Ultra-violet bands of mercury iodide molecule. V. C. Ramasastry. *Proc. Nat. Inst. Sci. India*, **18**, 487–90 (*Nov.–Dec.*, 1952).

For Pt IV, see Abstr. 2779 (1948). The F_2-system of HgI bands lying in the region 2450–2380 Å are photographed on the Hilger Medium and Littrow Quartz Spectrographs. About 40 bands could be measured. The closing up of the bands towards the long wavelength end is explained by a vibrational analysis which includes six lower state progressions. The vibrational level intervals in the lower state decreases from 98 to 30 cm^{-1} in about 22 steps and those of the upper state from 44 to 21 cm^{-1} in 4 steps leading to extrapolated dissociation limits of 1603 cm^{-1} and 220 cm^{-1} respectively above the lowest observed vibrational levels. It is suggested

...but the band system may not involve the ground state but may be due to a transition between two excited states. A.

535.338.4–31

3115. Band spectrum of carbon-disulphide. III. C. RAMASASTRY. *Proc. Nat. Inst. Sci. India*, **18**, 621–6 (*Nov.–Dec.*, 1952).

For Pt II, see Abstr. 8068 (1952). The near ultraviolet absorption bands of CS_2 in the region 3800–3550 Å are examined in the light of Mulliken's selection rules for $^1B_2$–$^1A_1$ electronic transition between a bent upper state and a linear lower state. Five progressions of bands each consisting of about 6 to 8 bands and involving intervals of 294 to 270 cm^{-1} are attributed to the ν_2' vibration. Some of these progressions which were observed in part by the earlier investigators are considerably extended and systematized. The $(0\,0\,0)'$–$(0\,0\,0)''$ transition is located at ν 27404 in the 3650 Å region. Retaining Liebermann's interpretation of two of these progressions, the various progressions, separated from the $(0\,v\,0)'$–$(0\,0\,0)''$ by 388, 800, 770 and 1200 cm^{-1}, are represented as $(0\,v^1\,0)'$–$(0\,1^1\,0)''$; $(0\,v^0\,0)'$–$(0\,2^0\,0)''$; $(0\,v^2\,0)'$–$(0\,2^2\,0)''$, and $(0\,v\,0)'$–$(0\,3\,0)''$; the last one however is forbidden by these selection rules (the top numerals on the central quantum numbers indicate the gyrovibronic quantum number K in the bent upper state and the azimuthal quantum number l in the linear lower state). Expressing the gyrovibronic energy as $C\,K(K+1)$, the constant C could be assigned an approximate value of 5 cm^{-1}. A.

535.343

3116. On the existence of a hidden transition in biphenyl. A. WENZEL. *J. chem. Phys.*, **21**, 403–8 (*March*, 1953).

The 2500 Å transition of biphenyl is interpreted as a superposition of a strong and a weak transition corresponding to the 2100 Å and 2600 Å transitions of benzene. Evidence for the location of the weak transition near 2700 Å is given. The spectra of the *m*- and *p*-polyphenyls are interpreted similarly to the biphenyl spectrum. Bending has about the same effect on the intensity and the position of the first strong transition of polyphenyls with *m*- and *p*-structure as it has on the corresponding transition of cata condensed hydrocarbons. A.

535.343 : 535.5

3117. Polarization absorption spectra of oriented dye molecule. L. V. SMIRNOV. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7) 68–77 (1952) *In Russian.*

The polarization absorption spectra of various dyes supported in an anisotropic medium were studied. The method consisted of measuring spectra of stretched films of polymers dyed by mixing an aqueous solution of dye with an aqueous solution of a polymer. The following dyes were investigated: azo, azino, di- and triphenyl methane, and polycyclic structures. Linear polymers, transparent in visible and ultraviolet regions, were used as medium. Wider variation in concentration and orientation is possible than in older methods of orientation such as adsorption on crystal faces. Theory of polarization of spectrum orientation of long chains of conjugated bonds is given. Use of the sign of the dichroism to determine orientation of the dye molecules relative to the axis of stretching, and thus to the axis of the straight-chain polymer molecules, is described. E. RABKIN

535.343 : 539.132

3118. Calculation of light absorption of acenes with the aid of the spreading electron-gas model of H. Kuhn. H.-H. PERKAMPUS. *Z. Naturforsch.*, **7a**, 594–602 (*Sept.*, 1952) *In German.*

The π-electron gas is allowed to spread along the entire molecular skeleton. A number of partial paths lead at once to one-dimensional Schrödinger equations. Term values are obtained for the polyacenes; the long-wave absorption (1st and 3rd maxima) are shown to be in agreement with experiment to within 30–50 Å approximately. J. JACOBS

535.343–15 : 535.375.5

3119. Vibration spectra of *cis* and *trans* dichloroethylene-d_1. H. J. BERNSTEIN AND A. D. E. PULLIN. *Canad. J. Chem.*, **30**, 963–72 (*Dec.*, 1952).

The infrared spectra of the vapour and the liquid, and the Raman spectra of liquid *cis* and *trans* C_2HDCl_2 have been obtained in the region 400–3300 cm^{-1}. The observed spectra are in accordance with the assignment of Bernstein and Ramsay for *cis* and *trans* $C_2H_2Cl_2$ and $C_2D_2Cl_2$. [Abstr. 5326 (1949)]. A.

535.343–15 : 535.375.5

3120. Substituted methanes. XIII. Infrared spectral data and assignments for dibromodifluoro methane. C. E. DECKER, F. F. CLEVELAND AND R. B. BERNSTEIN. Letter in *J. chem. Phys.*, **21**, 189–90 (*Jan.*, 1953).

For Pt XII, see Abstr. 1521 (1953). Infrared spectra and Raman spectra were taken of CBr_2F_2. The i.r. frequencies observed, their intensities and their assignments are tabulated. Some new bands were found and the others agree well with previous experimental results. There will be another report on the Raman lines. A. J. TAYLOR

535.343–31

3121. The absorption spectrum of PbBr molecule in the ultraviolet region. P. K. SUR AND K. MAJUMDAR. *Indian J. Phys.*, **26**, 111–14 (*March*, 1952).

A new system of bands comprising about a dozen bands degraded to violet was observed in absorption in the ultraviolet region between λλ2927–2701 Å. No splitting of the heads of the bands either due to structure or due to isotopic molecule $PbBr^{81}$ was detected. The heads fit in the formula $\nu = 34\,760{\cdot}21 + 259(v' + \frac{1}{2}) - 0{\cdot}5(v' + \frac{1}{2})^2 - 207{\cdot}4(v'' + \frac{1}{2}) + 0{\cdot}45(v'' + \frac{1}{2})^2$. The ground state constants agree well with those determined by Frank and Morgan for the absorption of $PbBr^{79}$ molecule in the visible region between λλ4400 and 5400 Å. A.

535.343.1 : 537.566

3122. Effects of ionization in an air-acetylene flame. C. T. J. ALKEMADE. *Physica*, **18**, 933–4 (*Nov.*, 1952).

The variation of light-emission with content of potassium (introduced into the flame as KCl dissolved in 0·15N HCl, 1–4 mg per 100 ml) was determined at heights of 10 mm and 23 mm above the blue combustion zone. The enhancement of *K*-emission due to the presence of added Na was also measured. Discrepancies between the experimental observations and theoretical predictions are explicable on the

assumption that the flame itself (without the addition of metal vapour) contains free electrons, whose concentration decreases with distance from the combustion zone. The concentration of such electrons at a point 23 mm above the combustion zone was found to be $1 \cdot 1 \times 10^{11}$ electrons/cm^3 ($\pm 30\%$). A. SCHOFIELD

535.343.2/.3–15

3123. The infra-red absorption bands associated with the COOH and COOD groups in dimeric carboxylic acids. I. The region from 1500 to 500 cm^{-1}. D. HADŽI AND N. SHEPPARD. *Proc. Roy. Soc. A*, **216**, 247–66 (*Jan.* 22, 1953).

The i.r. spectra of a considerable number of carboxylic acids and their COOD derivatives have been investigated between 1500 and 500 cm^{-1}, as dimeric units in the liquid or crystalline solid states. Under these conditions the COOH group is shown usually to give rise to strong absorption bands in the regions 1420 ± 20, 1300 ± 15 and 935 ± 15 cm^{-1}. The first two of these are found to correspond to closely coupled OH deformation and C—O stretching vibrations occurring in the plane of the $(COOH)_2$ dimeric ring; the latter is caused by the out-of-plane OH deformation vibration. COOD groups have absorption bands in the ranges 1350 ± 50, 1050 ± 10 and 675 ± 25 cm^{-1}, which can be assigned respectively to the C—O stretching mode and the in-plane and out-of-plane OD deformation vibrations. Less constant absorption bands of the COOH group between 700 and 575 cm^{-1} are attributed to O—C=O skeletal deformation vibrations, and the corresponding bands are found at slightly lower frequencies in the spectra of the COOD derivatives. The results of the i.r. investigation are compared with the Raman spectra of such acids and with related i.r. and Raman frequencies of other molecules. Infrared spectra of some equimolecular mixtures of acids with water have also been studied. A.

535.343.2/.3–31

3124. Absorption spectra of organic substances in the liquid and solid states. II. Cresols. H. N. SWAMY. *Indian J. Phys.*, **26**, 119–25 (*March*, 1952).

For Pt I, see Abstr. 5668 (1952). The absorption spectra of extremely thin films of *o*-, *m*- and *p*-cresols in the liquid state and in the solid state at low temperatures have been investigated, and bands have been observed. The results have been compared with those reported by previous workers for the vapour state of the substances and also for the solution of these substances in heptane. It has been observed that in all the three cases, the number of bands diminish with the liquefaction of the substance and further the ν_0-band shifts towards the longer wavelength. It is pointed out that such a shift may be due to association of molecules in the liquid state and the diminution in the number of bands with liquefaction may be due to the influence of the impact of the surrounding molecules on the vibration of individual molecules in the liquid. It is further observed that the bands shift towards shorter wavelength when the liquids are solidified and, in the case of *p*-cresol, the number of bands increases with solidification. The companions of the ν_0-band in the case of *p*-cresol represent transitions to higher harmonics of the mode of frequency 825 cm^{-1} of the benzene nucleus. It is pointed out that the increase in the electronic energy of the molecule with solidification may be due to contraction of the molecules which also increases the frequency of some of the modes of vibration of the molecule. Also, it is concluded that higher harmonics of some of the modes of vibration are allowed in the case of solid *p*-cresol probably because the pseudo-symmetry of the molecule in the crystal allows some space around the benzene nucleus of the molecule. A.

535.343.2/.3–31

3125. Absorption spectra of organic substances in the liquid and solid states. III. Some substituted benzene compounds. H. N. SWAMY. *Indian J. Phys.*, **26**, 233–42 (*May*, 1952).

The u.v. absorption spectra of thin films of *o*- and *p*-xylene, benzyl alcohol and benzyl chloride in the liquid state at room temperature and in the solid state at low temperatures have been investigated. The results have been compared with those reported by previous workers for the vapour state of the substances and also for solution of these substances in various solvents. Discrete bands have been observed for the liquid state in all these substances. *o*-Xylene produces only three bands in the liquid state while on solidification and cooling to −180°C six new bands appear. *p*-Xylene, on the other hand, produces six bands in the liquid state and at −180°C, eleven bands are observed. Most of the frequencies observed in the solid state of *p*-xylene can be attributed to the vibration of the benzene ring. It is pointed out that the symmetry of the molecule allows the benzene ring to execute vibrations probably because there is much space around the molecule even in the solid state. Five bands are observed in the case of benzyl alcohol both in the liquid and solid states. The bands become sharp and shift towards shorter wavelength with solidification. The bands in the liquid state shift considerably towards longer wavelength from their corresponding position in solution. It is concluded that the molecules in this case are already associated in the liquid state through virtual bonds and the association of molecules is not strengthened on solidification. In benzyl chloride also very little changes are observed on solidification of the substance and the main change occurs in the absorption spectrum with liquefaction of the vapour. It is concluded that the molecules in the liquid are strongly associated. A.

535.343.2/.3–31

3126. On the ultraviolet absorption spectra of organic substances in the liquid and solid states. III. Ethylbenzene and isopropylbenzene. A. R. DEB. *Indian J. Phys.*, **26**, 201–6 (*April*, 1952).

For Pt II, see Abstr. 5669 (1952). These have been studied in the 2440 Å–2850 Å region at low temperatures. In the case of ethylbenzene 8 bands have been observed for the liquid state with the 0–0 band shifted by about 335 cm^{-1} towards longer wavelength side from its position in the vapour state. In the solid state three new bands, in addition to these, are observed in the shorter wavelength side and the whole spectrum is also shifted slightly towards the shorter wavelength side. In the case of isopropyl benzene only three broad bands have been observed in the liquid state

with the 0–0 band considerably shifted towards the longer wavelength side. No appreciable shift of the band system towards the shorter wavelength side is observed when the liquid is solidified; but the third band extends more towards the shorter wavelength side, giving the appearance of a new band there. These facts have been explained on the assumption that impacts of molecules in the liquid state quenches higher harmonics of vibration and that the nature of packing in the crystalline state determines the number of such modes allowed in the solid state. The shift taking place on liquefaction is attributable to formation of strongly associated groups in the liquid. A.

535.343.2

3127. Absorption spectrum of cuprous oxide in the visible region. M. HAYASHI. *J. Fac. Sci. Hokkaidô Univ. II*, **4**, 107–28 (*March*, 1952).

A very thin plate of Cu_2O and special absorption tubes were used. There appeared (i) two sharp absorption edges forming a doublet, (ii) hydrogen-like absorption lines adjoining an absorption band, and (iii) another absorption band at the wavelength much shorter than those of the hydrogen-like lines. The doublet separation is found to be 0·028 eV (226 cm^{-1}), which coincides with that of the ground state ^2P of O^-. Thus it is concluded that the filled band of Cu_2O corresponds to $(2p)^6$ of O^{--}. The energies of the two absorption edges are 2·032 eV and 2·004 eV at 0°K and coincide, within the estimated error, with that of electron affinity of oxygen atom. These edges are, therefore, interpreted as the so-called electron affinity spectrum in absorption. As regards the hydrogen-like lines, they can be expressed by the equation E (eV) $= 2{\cdot}161 - 0{\cdot}090/n^2$ (at $-$ 184°C), of which the absorption line corresponding to $n = 1$ is missing, and their series limit corresponds to the energy of the lowest level of the empty band. Further, the temperature dependency of the two absorption edges and the hydrogen-like lines has been investigated in the region between $-$184°C and $+$150°C. The obtained results are in qualitative agreement with the theoretical expectation. The other absorption band mentioned above seems to indicate the splitting of the empty band and to support the opinion for some crystals (Cu_2O, etc.) of Bruining and De Boer, who studied the secondary electron emission of ionic crystals. A.

535.343.2

3128. Interaction of methylene deformation frequencies in paraffin crystals. R. S. STEIN AND G. B. B. M. SUTHERLAND. Letter in *J. chem. Phys.*, **21**, 370–1 (*Feb.*, 1953).

Investigations on the doublet at 14 μ in polymethylene hydrocarbons, describing a number of properties of the two components, which can be explained by a superposition of spectra of the crystalline and amorphous forms. C. TURNER

535.343.2–15

3129. Infra-red spectra of coal and coal products. C. G. CANNON. Letter in *Nature* [*London*] **171**, 308 (*Feb.* 14, 1953).

Spectra are taken of eighteen samples of bright coal of various ranks from several British coalmines. Humic acids, pyridine and aniline extracts from coal were also examined. The average absorption intensity was more or less constant for lower-rank coals, higher for coking coal and very much higher for low-volatile steam coal. The last phenomenon can be correlated with higher optical anisotropy and with higher orientation towards the graphite structure. In all other coals the molecular structure is generally the same. The spectra indicate the presence of single rings as well as condensed aromatic structures. Aliphatic groups can also be detected. For low-rank coal the pyridine extracts showed spectra similar to that of the original coal. The humic acid spectra were different and resembled those of graphitic and mellitic acid. A. J. TAYLOR

535.343.2–15

3130. Absorption spectra of lead sulphide at different temperatures. W. PAUL AND R. V. JONES. *Proc. Phys. Soc.* [*London*] *B*, **66**, 194–200 (*March*, 1953).

The absorption spectrum, as measured between 1 and 10 microns, shows a sharp decrease (in some specimens from 100 cm^{-1} to 5 cm^{-1}) in the absorption coefficient at a wavelength corresponding to the limit of photoconductivity. In many galena crystals additional absorption exists that masks completely the sharp absorption edge. The absorption edge and the photoconductive limit change their position similarly with temperature, the rate of shift of the edge being $+3{\cdot}7\times10^{-4}$ eV/°K between 90°K and 400°K. The shift is in the opposite direction to that observed in the elementary semiconductors Si and Ge. At long wavelengths the absorption coefficient increases with the square of the wavelength, but there is a large discrepancy between the magnitude of the measured absorption coefficient and that calculated on the free electron theory. The long wavelength absorption increases with the temperature; this may correspond either to an increase in the number of carriers or to a decrease in their mobility. A.

535.343.2–15

3131. The infrared spectra of tetranitromethane. P. H. LINDENMEYER AND P. M. HARRIS. *J. chem. Phys.*, **21**, 408–14 (*March*, 1953).

Cooling curve investigations show that the transition between the two crystalline forms of tetranitromethane occurs at $-$99·8°C and its character suggests an order-disorder transformation. The infrared spectra of tetranitromethane were obtained at 25°C (vapour), 18°C (liquid), $-$40°C (solid I), $-$88°C (solid I), $-$140°C (solid II) and $-$126°C (solid II). The spectra of the vapour are best interpreted by a molecule with $S_4 - 4$ symmetry whereas reported Raman spectra indicate $D_2d - 42m$ symmetry in the liquid. Satisfactory agreement between these and the X-ray diffraction data require molecules of both symmetries. A complete lack of selection rules was observed in the spectra throughout the solid range. A.

535.343.3 : 539.133

3132. Structure of proteins in solution and structural modifications produced by denaturation. H. LENORMANT. *Bull Soc. Chim. France*, **20**, 214–22 (*Feb.*, 1953) *In French.*

A general discussion of the various theories of protein structure, in particular the configuration of

the α-fold, is followed by the results of an investigation on the absorption spectra of proteins. The spectral region investigated is 4–8 μ and use is made of the fact that heavy water is transparent in this region. Four groups of experiments were carried out on various proteins and on some synthetic peptides. (1) The effect on the spectra of replacing the hydrogen of the amino acid NH group by deuterium. The band at 6·4–6·5 μ moves to 6·7–6·9 μ in all cases. (2) The effect of solution on the spectra of deuterium-treated substances. In the case of some simple amides the bands move when the substance is dissolved in D_2O but in the case of the proteins and the synthetic polypeptides no change in the position of the bands can be detected. (3) The effect of denaturation, by heating, is shown to be due to the change from the α-configuration to the β-configuration. (4) The effect of certain ions on the spectra is studied, in particular the action of copper ions. It is concluded that the α-configuration of native proteins remains unchanged on solution and that the intra-molecular hydrogen bonds must remain unaffected. The appearance of the β-structure indicates denaturation and it is suggested that the peptides of native protein are synthesized in the α-form since there does not appear to be any possibility of the change from β to α taking place in the living cell. J. IBALL

535.343.3–14

3133. Some heavy water rotational absorption lines. C. K. Jen, D. R. Bianco and J. T. Massey. *J. chem. Phys.*, **21**, 520–5 (*March*, 1953).

Three new heavy water rotational absorption lines have been observed in the microwave region. One of these lines and another line previously observed by McAfee have been identified as HDO lines by a study of the variation of their intensities with isotopic molecular concentration. By interpreting their Stark structure, the two HDO lines are assigned as follows: HDO : $8_{-1} \rightarrow 8_0$ at 24 884·85 Mc/s and HDO : $6_{-2} \rightarrow 7_{-6}$ at 26 880·47 Mc/s. In addition, results on the Zeeman spectra of the two identified HDO lines are presented. A.

535.343.32

3134. Note on the absorption spectrum of iodine in oxygenated solvents and the dissociation of iodine water. L. I. Katzin. *J. chem. Phys.*, **21**, 490–1 (*March*, 1953).

Data are presented on factors in the appearance of the tri-iodide absorption spectrum in solutions of iodine in water and in the alcohols. Some implications of the dissociation of iodine in water for the theory of the iodine-solvent interaction are pointed out. A.

535.343.4–14

3135. Microwave absorption spectrum of ND_3. R. G. Nuckolls, L. J. Rueger and H. Lyons. *Phys. Rev.*, **89**, 1101 (*March* 1, 1953).

The main $J = K$ sequence of inversion lines of the ND_3 absorption spectrum were observed and measured between 1589 and 2540 Mc/s. Quantum numbers up to J, $K = 18$, 18 were assigned by the use of an approximate empirical formula. A.

535.343.4–14 : 539.133

3136. The microwave spectrum and structure of methylene fluoride. D. R. Lide, Jr. *J. Amer. Chem. Soc.*, **74**, 3548–52 (*July* 20, 1952).

The *K*-band microwave spectrum of the slightly asymmetric rotor CH_2F_2 has been recorded and analysed. Many of the lines appear as close doublets which are due to asymmetry splitting of levels which would be degenerate in the limiting symmetric rotor. The rotational constants determined from the three lines of lowest J values are $a = 49\,138{\cdot}4$ Mc/s; $b = 10\,603{\cdot}89$ Mc/s; and $c = 9249{\cdot}20$ Mc/s. With the aid of two lines of $C^{13}H_2F_2$ the following structural parameters have been calculated: $r_{CF} = 1{\cdot}358 \pm 0{\cdot}001$Å, $r_{CH} = 1{\cdot}092 \pm 0{\cdot}003$Å, $<FCF = 108° 17' \pm 6'$, $<HCH = 111° 52' \pm 25'$. Stark effect measurements give dipole moment of $1{\cdot}96 \pm 0{\cdot}02$ debye units. A.

535.343.4–14 : 539.27

3137. Electron diffraction and microwave investigation of tertiary butyl fluoride. F. Andersen, J. R. Andersen, B. Bak, O. Bastiansen, E. Risberg and L. Smedvik. Letter in *J. chem. Phys.*, **21**, 373 (*Feb.*, 1953).

535.343.4–15

3138. Contribution to the study of the vibration spectrum of nitrous oxide. M. L. Grenier-Besson, G. Amat and P. Barchewitz. *C.R. Acad. Sci. [Paris]* **235**, 1636–7 (*Dec.* 22, 1952) *In French.*

The infrared absorption spectrum of N_2O is taken between 1·5 μ and 2·5 μ. Apart from the two known parallel bands at 4734·7 and 4419·5 cm^{-1} seven parallel and two perpendicular bands are observed. The accuracy is 1 cm^{-1}. The bands are tabulated and interpreted. A. J. TAYLOR

535.343.4–15

3139. Infrared spectrum of CD_3Br under high dispersion (2900 to 3400 cm^{-1}). C. Courtoy. *Ann. Soc. Sci. Bruxelles*, **66**, *No.* 3, 173–7 (1952) *In French.*

535.343.4–15

3140. Some bands of methyl bromide in the near infrared under high resolution. D. H. Rank, H. D. Rix and T. A. Wiggins. *J. Opt. Soc. Amer.*, **43**, 157–62 (*March*, 1953).

A method of measurement of absolute wavelengths of absorption bands in the i.r. is described. A Fabry–Perot etalon with bare glass plates is interposed in series with the absorption tube which superimposes the Edser Butler type fringes on the absorption spectrum. The methods used for calibration of the etalon are described. The precision of frequency measurement is of the order of $\pm 0{\cdot}02$ cm^{-1} in the region of 1·7 μ. The absorption bands of CH_3Br in the region 5800 to 6200 cm^{-1} were measured by this method. Two parallel and three perpendicular bands are reported. The *P*, *Q* and *R* structure of the parallel component of the $2\nu_4$ band was well resolved, enabling the determination of $\nu_0 = 6046{\cdot}42$, $B' = 0{\cdot}31875$ and $A' = 5{\cdot}02_7$ cm^{-1}. The separation of the *P* and *R* maxima of the $2\nu_1$ is 23 cm^{-1}. The band origins of the perpendicular components $2\nu_4(6095{\cdot}61$ $cm^{-1})$, $\nu_4 + \nu_1(5940{\cdot}4$ $cm^{-1})$ and $\nu_4 + 2\nu_5(5878{\cdot}1$ $cm^{-1})$ were determined on the basis of intensity and alternation of intensity due to nuclear spin of the *H* atoms. ζ for the perpendicular component of $2\nu_4$ was determined as $-0{\cdot}128$. A.

535.343.4–15

3141. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. IX. The spectra of the HCN and DCN molecules from 2·5μ to 0·5μ. A. E. DOUGLAS AND D. SHARMA. *J. chem. Phys.*, **21**, 448–58 (*March*, 1953).

For Pt VIII, see Abstr. 5031 (1952). The photographic i.r. spectrum of HCN has been investigated using a 6 m concave grating spectrograph and absorption paths up to 600 m. The near i.r. spectra of HCN and DCN have been investigated using a grating i.r. spectrometer with a PbS cell as a detector. The interference fringes from a Fabry–Perot etalon have been used as wavelength standards for the recording spectrometer. Twenty-four bands of HCN and six bands of DCN have been measured. From these measurements earlier work has been corrected, and the zero-order frequencies and anharmonic constants have been determined for both HCN and DCN. Perturbations have been found in the vibrational levels of HCN. Corresponding perturbations occur in the B_v values, and it has been shown that even apparently unperturbed B_v values are not linear functions of the vibrational quantum numbers. The B_e values for HCN and DCN were found to be $1{\cdot}4849\ cm^{-1}$ and $1{\cdot}2118\ cm^{-1}$. From these B_e values the C–H and C–N internuclear distances in the equilibrium position have been found to be 1·0657 Å and 1·1530 Å, respectively. From the zero-order frequencies the force constants have been determined. A.

535.343.4–15 : 535.375.5

3142. Infrared and Raman spectra of fluorinated ethanes. V. The series CF_3CF_3, CF_3CF_2Cl, CF_3CFCl_2, and CF_3CCl_3. J. R. NIELSEN, C. Y. LIANG, R. M. SMITH AND D. C. SMITH. *J. chem. Phys.*, **21**, 383–93 (*March*, 1953).

The infrared spectra of CF_3CF_2Cl, CF_3CFCl_2 and CF_3CCl_3 vapours have been obtained in the region from 2 to 38 μ, and the spectra of liquid CF_3CF_2Cl and CF_3CFCl_2 in the region from 2 to 22 μ, with the aid of LiF, NaCl, KBr and KRS–5 prisms. The Raman spectra of all three compounds in the liquid state, and of gaseous CF_3CF_2Cl, were studied with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. Depolarization ratios were determined for most of the Raman bands. All fundamental vibration frequencies except the lowest (torsional) have been assigned for each molecule, and the observed spectra have been interpreted in detail. A.

535.343.4–15 : 537.525.72

3143. Rotational intensity distributions of OH and OD in an electrodeless discharge through water vapor. H. P. BROIDA AND W. R. KANE. *Phys. Rev.*, **89**, 1053–4 (*March* 1, 1953).

The distributions of intensities of the rotational lines of the $^2\Sigma^+$–$^2\Pi$ transition of OH and OD in a high frequency electrodeless discharge through water vapour have been measured. Effects of water vapour pressures from 0·025 to 3·2 mm Hg and added A, He, N and O to 10 mm Hg have been studied. Two intensity maxima are found at the same energies in both OH and OD, corresponding to total energies in the excited state of 32 950 and 37 400 cm^{-1}. The position of the higher energy maximum is unaffected by pressure or added gas. This is interpreted as indicating that a lower limit of 150 collisions may be set for the collision lifetime for the transfer of rotational energy of the hydroxyl radical. The intensity of the lower energy maximum, which is probably of thermal origin, increases relative to the higher energy maxima with increasing water pressure and with added gas. A has the effect of increasing the intensity of the (0, 0) band by more than a factor of ten. A predissociation phenomenon previously found in OH is also observed in OD. A.

535.343.4–31

3144. Intensities of electronic transitions of acetylene in the vacuum ultraviolet. G. MOE AND A. B. F. DUNCAN. *J. Amer. Chem. Soc.*, **74**, 3136–40 (*June* 20, 1952).

The absolute intensities of 13 separate electronic transitions in the region 1520–1050 Å have been measured quantitatively. A one-metre vacuum grating spectrograph was used to photograph the spectrum. Molecular hydrogen lines occurring in this region from a low-pressure hydrogen discharge tube were used as background for the absorption. Absorption coefficients were determined at wavelengths where these lines occurred, using the methods of photographic photometry. "Oscillator strengths" (*f*-numbers) for the transitions were found. The values obtained are compared with theoretical *f*-numbers calculated from approximate wave functions. A.

535.343.4–31

3145. Intensity of electronic transitions of methane and carbon tetrafluoride in the vacuum ultraviolet. G. MOE AND A. B. F. DUNCAN. *J. Amer. Chem. Soc.*, **74**, 3140–3 (*June* 20, 1952).

The absolute intensities of some electronic transitions of methane and carbon tetrafluoride in the vacuum ultraviolet have been measured. *f*-numbers for these transitions were calculated and compared with experimental values. The nature of the transitions is discussed. A.

535.343.4–32

3146. The ultra-violet absorption spectrum of nitric oxide. L. H. SUTCLIFFE AND P. A. D. WALSH. *Proc. Phys. Soc.* [*London*] *A*, **66**, 209–16 (*March*, 1953).

New photographs of the absorption spectrum of NO have been obtained. Three red-degraded bands between 1711 and 1676 Å resemble the β bands and plausibly represent the $v' = 14$, 15, 16 members of the β system. An intensity and spacing anomaly between the $v' = 13$ and $v' = 14$ members is probably connected with the diffuseness and disturbance in position of the $v' = 2$ member of the δ system and the failure of the $v' = 3$ member of that system to appear; and can be accounted for in terms of a crossing of the $B^2\Pi$ and $C^2\Sigma^+$ potential energy curves. The β system suffers a further disturbance when the $B^2\Pi$ curve cuts the $D^2\Sigma^+$; the $v' = 17$ member of the β system appears to be replaced by the $v' = 3$ member of the ε system. There is no need to introduce a hypothetical repulsive curve to explain the perturbations of the various systems; they all appear to be explicable in terms of successive crossings of the

$^2\Sigma^+$ curves by the $B^2\Pi$ potential curve. All the states A, C, D and E involve extra-valency shell (Rydberg) orbitals. Plausible interpretations of these states are given. A.

535.343.4–32

3147. The absorption spectrum of cyclopropane in the vacuum ultraviolet. Note on the absorption spectrum of methyl cyclopropane. P. WAGNER AND A. B. F. DUNCAN. *J. chem. Phys.*, **21**, 516–19 (*March*, 1953).

The spectrum of cyclopropane has been investigated from 600 Å to 2200 Å with high dispersion. Three very broad electronic transitions with apparent maxima at 1594, 1449 and 1202 Å were found. A strong continuous absorption begins at 1123 Å, and no resolved transitions could be observed at shorter wavelengths. A very weak band system consisting of twelve bands was found between 1889 and 1816 Å. It is concluded that the electronic transitions arise from excitation of an electron from a bonding molecular orbital localized principally in the carbon ring. The weak transition is interpreted as a forbidden transition. A tentative analysis of the bands in this transition is given. A note on the absorption spectrum of methyl cyclopropane is included. A.

535.345–15

3148. Infra-red transmission limits of single crystals of some fluorides. D. A. JONES, R. V. JONES AND R. W. H. STEVENSON. Letter in *Proc. Phys. Soc. [London] B*, **65**, 906–7 (*Nov.*, 1952).

Sizeable crystals of strontium, barium, cadmium and lead fluorides have been grown, using Stockbarger's methods, for investigation of their optical properties. W. BARDSLEY

535.345.32–15

3149. Infrared spectra and structure of uranyl and transuranium (V) and (VI) ions in aqueous perchloric acid solution. L. H. JONES AND R. A. PENNEMAN. *J. chem. Phys.*, **21**, 542–4 (*March*, 1953).

Infrared spectra of aqueous solutions of U (VI), Np (VI), Pu (VI) and Am (VI) show conclusively that these ions exist as symmetrical and linear, or nearly linear, XO_2^{++}. The spectra of Np (V) and Am (V) show that they are probably XO_2^{+} ions. Force constants and estimated distances are given for the X–O bonds. For the XO_2^{++} series, the X–O force constant is expressed as a parabolic function of atomic number, with the maximum occurring at NpO_2^{++}. This is contrary to behaviour expected if there were a regular contraction in ionic radii for the series XO_2^{++}.

535.35 : 536.462 : 539.132

3150. Effects of vibrational state on rotational intensity distributions in OH. A. M. BASS AND H. P. BROIDA. Letter in *J. chem. Phys.*, **21**, 173 (*Jan.*, 1953).

Rotational temperatures have been derived from six bands of the $^2\Sigma$–$^2\Pi$ system emitted above the reaction zone of an H_2–O_2 flame. Significant differences are found from band to band, which may arise from the neglect of vibration-rotation interaction in the calculations of transition probability.

R. F. BARROW

535.371

3151. Luminescence of calcium compounds. V. I. LISIN. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 2 (8) 238–9 (1952) *In Russian.*

A report of a study of the luminescence of chalk and natural compounds of calcium. With rising temperature there is an increase in the wavelength of the emitted light. Chemically pure calcium compounds do not luminesce. Apparently an impurity causes a chemiluminescence. E. RABKIN

535.371

3152. The use of solid solutions of para-terphenyl and tetraphenylbutadiene in polystyrene as scintillation phosphors. H. DE WAARD AND J. E. P. MARTINI. Letter in *Physica*, **18**, 647–50 (*Aug.–Sept.*, 1952).

Polystyrene cylinders of height 10 cm and diameter 26 mm containing 1·4% PT or TPB were polymerized with 0·2% benzoyl peroxide for 100 hours at 70°C and then for 150 hours at 90°C. Other dimensions were also used and all cylinders irradiated with Co^{60} rays. The TPB plastic showed much better characteristics than the PT plastic and approaches the performance of the less easily obtainable crystalline stilbene. J. EWLES

535.371

3153. Polarization of fluorescence of dissociated molecules. W. HANLE AND A. SCHARMANN. Note in *Z. Naturforsch.*, **7a**, 635–6 (*Sept.*, 1952) *In German.*

The fluorescence of aminopyrosulphate in aqueous solution changes from green to yellow in colour as alkalinity is increased. The latter increase causes dissociation of protons from the molecules but polarization and decay time observations indicate that the electronic configuration of the molecules is not markedly affected by the proton loss.

G. F. J. GARLICK

535.371

3154. On the quenching of photoluminescence in zinc sulphide. P. S. LITVINOVA. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7), 101–4 (1952) *In Russian.*

An investigation of the dependence of the relative quantum yield of photoluminescence of ZnS on the intensity of the exciting light at various temperatures has been made. The excitation was produced by the mercury lines 3125 and 3650 Å. The experimental procedure is described in a previous work [Abstr. 874 (1950)]. It was shown that the yield changes from one constant value at small intensities of excitation to a different constant value at large intensities of excitation. At intermediate intensities there is a region of variable values for the yield.

E. RABKIN

535.371

3155. A magnesium oxide phosphor activated by tetravalent manganese. J. S. PRENER. Letter in *J. chem. Phys.*, **21**, 160–1 (*Jan.*, 1953).

Magnesium oxide, containing 0·1 mole % manganese sulphate and ·5 mole % lithium carbonate, fired in O_2 at 1000°C gives ultraviolet excited red luminescence with spectral bands of some complexity. Firing in H_2 or omission of Li_2CO_3 gives a broad emission band with maximum at 7300 Å excited only by cathode rays, suggestive of Mn^{++} centres.

Chemical analysis of the first type of phosphor indicates the presence of tetravalent manganese. This analysis is supported by microwave paramagnetic resonance experiments on the two types of phosphor. G. F. J. GARLICK

535.371

3156. The effects of neutron bombardment on a zinc sulphide phosphor. A. W. SMITH AND J. TURKEVICH. Letter in *J. chem. Phys.*, **21**, 367–8 (*Feb.*, 1953).

The luminescence efficiency, thermal glow, dielectric changes, etc., of a ZnS phosphor are studied before and after neutron bombardment. Damage produced is partly removed by heating at 200°c but a temperature of 900°c is needed for complete removal of neutron effects. The damage can be distinguished from that produced in the phosphor by grinding. G. F. J. GARLICK

535.371

3157. On the nature of fluorescent centers and traps in zinc sulfide. H. A. KLASENS. *J. Electrochem. Soc.*, **100**, 72–80 (*Feb.*, 1953).

The impurity levels in the energy diagram of a ZnS phosphor are considered to be localized S^{2-} levels lifted above the filled S^{2-} band due to the presence of monovalent positive or trivalent negative activator ions in the lattice. Electron traps are formed similarly by the substitution of S ions by monovalent negative ions or of Zn^{2+} ions by trivalent positive ions. The energy produced when electrons recombine with trapped holes or when holes recombine with trapped electrons is either emitted directly as light or is first transferred to impurity ions. The elements of the iron group give rise to electron traps. The killing action of these elements is explained by assuming that the energy liberated by recombination between holes and electrons in these traps is transferred to the killer ions. The excited ions return to the ground state radiationless because of the presence of many electronic levels between the excited and the ground state. The effect of heat and infrared radiation on the luminescence is discussed. It is shown that, in a phosphor, energy may be transferred by electrons through the conduction band or by holes through the occupied S^{2-} band. A.

535.371

3158. Optical measurements on electroluminescent zinc sulfide. J. F. WAYMOUTH. *J. Electrochem. Soc.*, **100**, 81–4 (*Feb.*, 1953).

Absorption and emission spectra of electroluminescent ZnS phosphors, activated by Cu and Pb, are reported. Three absorption bands are observed, at 3·18 eV, at about 2·7 eV, and somewhere below 1 eV. The infrared absorption band is associated with the Pb activator but its exact location is uncertain. The emission spectra of both blue and green phosphors may be resolved into the same emission bands, at 2·15, 2·4 and 2·7 eV, respectively. The primary difference between the spectra of blue phosphors and green phosphors lies in the ratio of the amplitudes of the green and blue bands. This ratio is also shown to be a function of the frequency of the applied alternating field, but is independent of the magnitude of the field. A.

535.371

3159. Electron trapping states in phosphors. R. T. ELLICKSON. *J. Opt. Soc. Amer.*, **43**, 196–7 (*March*, 1953).

It is known both theoretically and experimentally that the energy gap in polar crystals decreases with temperature, the change being about 0·0005 eV/deg. It is shown that one effect of this change is that phosphorescent decay measurements at different temperatures give indicated oscillation frequencies for trapped electrons which are too high by a factor of the order of 100. Since these apparent frequencies are already several orders of magnitude less than crystal oscillation frequencies, the indications are that the electron frequencies are not closely connected with crystal oscillation frequencies. It is shown further that the variation of energy gap with temperature may account for the few cases where thermal activation energies are larger than optical activation energies. A.

535.371

3160. Polarized fluorescence of molecules of some single organic crystals. S. C. GANGULY AND N. K. CHOUDHURY. *J. chem. Phys.*, **21**, 554–7 (*March*, 1953).

The polarized fluorescence of single crystals of pyrene, phenanthrene and benzil have been studied. It has been observed that, whether the incident light is polarized or not, the fluorescent light is polarized in all three cases. From the study of the intensity of fluorescence light the directions of oscillators, and so the favoured condition of excitation of fluorescence with particular reference to the crystal structure, have been determined, and an attempt has been made to find the orientation of the molecules with reference to the crystal axis where the structure is not known. A.

535.371

3161. Interaction of manganese activator ions in zinc-orthosilicate phosphors. S. LARACH AND J. TURKEVICH. *Phys. Rev.*, **89**, 1060–5 (*March* 1, 1953).

A study was made of specially prepared rhombohedral Zn_2SiO_4 : Mn phosphors, utilizing magnetic, chemical and luminescence techniques. From measurements of Weiss constants, it is shown that magnetic interaction occurs between Mn activator ions. The magnetic interaction increases with increasing proportion of Mn in the range where the following related luminescence characteristics decrease: (1) efficiency, (2) temperature break-point, and (3) decay time. An analysis of the magnetic data shows that isolated noninteracting Mn activator ions have five unpaired electrons, corresponding to Mn^{2+}, and $\bar{\mu} = 5{\cdot}90$ Bohr magnetons (5·92 theoretical). The molar diamagnetic susceptibility of zinc-orthosilicate was determined as being $(-64{\cdot}6 \pm 0{\cdot}7) \times 10^{-6}$. A.

535.371.07 : 537.36

3162. Streaming potential measurements and the adhesion of phosphors on cathode ray screens. J. F. HAZEL AND G. L. SCHNABLE. *J. Electrochem. Soc.*, **100**, 65–71 (*Feb.*, 1953).

Streaming potential measurements were carried out to determine the effect of $Ba(CH_3CO_2)_2$ on the ζ potentials of phosphor and glass surfaces in the

presence of K_2SiO_3. The results are compared with previous data for Na_2SO_4 as the addition agent. Although widely different concentrations of the two salts were required to depress the ζ potentials to the same low values, the concentrations corresponded to those which give good adhesion of phosphor to glass. The mechanism of adhesion is discussed. A.

535.372

3163. On the luminescence of some organic phosphors under X-rays and cathode rays. H. N. Bose, J. Sharma and A. Chatterjee. *Proc. Nat. Inst. Sci. India*, **18**, 389–98 (*Sept.–Oct.*, 1952).

The luminescence spectra of naphthalene, diphenyl, phenanthrene, triphenyl methane, anthracene, etc., excited by X-rays and cathode rays at room temperature as well as at liquid oxygen temperature are reported in this paper. Most of these phosphors show a long period afterglow. The decay of the long period afterglow of some of these phosphors under cathode rays has been measured at liquid oxygen temperature; the glow curves for some of these samples have also been recorded. A.

535.375.5

3164. The Raman spectrum of *p*-benzoquinone. H. Stammreich and R. Forneris. *Z. Naturforsch.*, **7a**, 756–9 (*Nov.*, 1952) *In German.*

In the double-bond frequency range only one vibration (1667 cm^{-1}) is observed and is attributed to the carbonyl group; no C = C frequency is present. Some details of experimental technique and difficulties in the long wavelength region are discussed; here the yellow He 5875·6 Å was used for excitation.

J. JACOBS

535.375.5

3165. Variation of the intensity of the Raman spectra with substitutions in the benzene nucleus and in the side-chain of cinnamyl chloride. M. Harrand and H. Martin. *C.R. Acad. Sci.* [*Paris*] **236**, 192–4 (*Jan.* 12, 1953) *In French.*

The intensities and positions of the observed Raman lines in the spectra of cinnamyl chloride, five methyl-substituted cinnamyl chlorides, and *oo'p*-trimethyl cinnamyl chloride are diagrammatically represented. The greatest Raman intensity is displayed by those compounds where the conjugated system is least disturbed by the substitution, i.e. the *m*- and *p*-substituted compounds. G. I. W. LLEWELYN

535.375.5 : 548.7

3166. Certain relationships in the spectra of combination scattering of low frequencies of isomorphous crystals of dihalogen-substituted benzene. E. F. Gross, A. V. Korshunov and V. A. Sel'kin. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 579–89 (1952) *In Russian.*

Experimental investigations are described of the low-frequency Raman spectra of isomorphous crystals which permit the assignment of some frequencies of the scattering spectra to the oriented vibration of molecules in the crystalline lattice. The assumption is proposed that the low-frequency lines of weak intensity detected in the spectra are excited by the translational vibrations of molecules which show up, contrary to the selection rules, as a result of the imperfections of the crystalline lattice. E. RABKIN

535.375.54

3167. Raman spectrum of hydrated aluminium chloride. A. Galy. *C.R. Acad. Sci.* [*Paris*] **236**, 284–6 (*Jan.* 19, 1953) *In French.*

The experimental results obtained for a monocrystal of $AlCl_3 . 6H_2O$ using polarized incident radiation are compared with those expected from theory. G. I. W. LLEWELYN

535.375.55

3168. On the Raman spectrum of solution of benzoyl chloride in benzene. T. A. Hariharan. *Indian J. Phys.*, **26**, 115–18 (*March*, 1952).

The Raman spectra of solutions of different concentrations have been investigated and the relative intensities of the lines 162 and 316 cm^{-1} observed in the case of solutions have been compared with those for the pure liquid at room temperature. It is found that the ratio of the intensity of the line 162 cm^{-1} to that of the line 316 cm^{-1} diminishes gradually as the concentration of the solution decreases. It is concluded from these results that the line 162 cm^{-1} may be due to intermolecular vibration in a dimer and that in the pure liquid such dimers are predominant while in the solution some of them break up into monomers. The relative intensities of the two lines, however, are found to diminish very slightly even at 150°C. A.

535.375.56

3169. The Raman spectra of vinyl- and dichlorovinyltrichlorosilane. H. Murata. Letter in *J. chem. Phys.*, **21**, 181–2 (*Jan.*, 1953).

Tentative assignations of the observed lines are made, and the results of an electron diffraction study of the vapours briefly discussed. G. I. W. LLEWELYN

535.376

3170. Influence of excitation levels on the luminescence in the ultra violet of alkali halide crystals coloured by X-rays. M. L. Kats. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 78–87 (1952) *In Russian.*

These phosphors show, as well as the *V* absorption bands (NaCl, $V_1 = 3450$ Å, $V_2 = 2226$ Å, $V_3 = 2100$ Å), emission bands in the ultraviolet with peaks at 2950 Å and 2400 Å. The centres responsible, D_1 and D_2 centres, are associated with positive holes, the first being regarded as a neutral halogen atom next to a positive ion vacancy and the second as a pair of vacant anion and cation sites next to a D_1 centre. The evidence for this view is drawn from thermal glow curves; from the effect of temperature of X-radiation on the light sum, from flash phenomena which occur when the X-rayed crystals are illuminated with light in the D_1 band and in the *F* band (outburst of ultraviolet), from calculations on the energy cycle involved. From the fact that a decrease in *F* band absorption is associated with the emission of u.v. luminescence it is concluded that the processes responsible are recombinations of *D* centres with *F* centres.

J. EWLES

535.376

3171. On the fluorescence excited by alpha-particles in stilbene. M. Ageno and G. Cortelleesa. *R.C. Ist. Super. Sanità*, **15**, *Pt III*, 159–61 (1952) *In Italian.*

Using the same photographic technique as used formerly for solutions [Abstr. 1667, 3490 (1952)] it

is shown that also in *trans*-stilbene excited by α-particles, the energy travels a few millimetres before being transformed into fluorescent light. A.

535.376

3172. Saturation and voltage effects in cathodoluminescence. P. H. DOWLING AND J. R. SEWELL. *J. Electrochem. Soc.*, **100**, 22–33 (*Jan.*, 1933).

The present work is an attempt at a quantitative study of the major phenomena of cathodoluminescence. Efficiency, current saturation and the relation of brightness to electron accelerating voltage are correlated with the stopping power of the phosphor crystal for electrons, the decay characteristics and the activator concentration. So far, exponential decay phosphors only have been considered and experiments have been made principally on Zn_2SiO_4 — Mn. Steady state excitation only is considered. The experiments confirm the theory fairly well and the following inferences can be drawn: (*a*) The principal relationship between brightness and accelerating voltage is a linear one. (*b*) For the first few kilovolts, this relationship is distorted because of a dead layer on the crystal surface averaging some 150 Å in thickness. (*c*) The electron beam loses energy along its penetration path in an exponential-like manner. (*d*) Within the approximate range 1 kV to 10 kV, the range of the primary electron beam varies as the first power of the accelerating voltage. Evidence is presented that above about 10 kV there is a transition to a faster-than-linear increase of range with voltage. (*e*) The brightness increases in a logarithmic manner with increasing current density. As far as current saturation alone is concerned, there is thus no real maximum brightness, at least for infinitely thick phosphor samples. (*f*) The current density at which saturation effects are noticeable is a function of the accelerating voltage. In the approximate range 1 kV to 10 kV it is practically constant. Above about 10 kV it increases with increasing voltage. (*g*) In Zn_2SiO_4 — Mn, the percentage of Mn ions which are effective luminescent centres decreases with increasing Mn content, reaching the order of 0·03% at 10 mole % total Mn content. A.

535.376

3173. The luminescence of irradiated transparent media and the Čerenkov effect. I. The luminescence of aqueous solutions of radioactive isotopes. E. H. BELCHER. *Proc. Roy. Soc. A*, **216**, 90–102 (*Jan.* 7, 1953).

Studies of the luminescence induced in aqueous solutions of radioactive isotopes are described. The relative intensities of the effects observed with various high energy β- and β-γ-emitting species support the hypothesis that the luminescence induced is due to the Cherenkov effect rather than excitation of the substrate. The relative and absolute intensities observed are in general agreement with the theory of Frank and Tamm (1937). Aqueous solutions of α-emitters, and of β-emitters whose β-particles have energies below the limit for the Cherenkov effect, show a weak luminescence attributable to excitation of the substrate. A.

535.376

3174. The luminescence of air, glass and quartz under α-particle irradiation. J. B. BIRKS AND J. W. KING. *Proc. Phys. Soc.* [*London*] *B*, **66**, 81–4 (*Feb.*, 1953).

The luminosity of a Po^{210} source has been detected using a photomultiplier technique. It is also found that photons are produced in air, glass and quartz when these materials are irradiated by α-particles. It is shown that the "scintillations" observed by Richards and Cole probably originated in these materials, and not in the various thin films to which they were ascribed. A.

535.376

3175. Thermoluminescence of ice. E. C. AVERY AND L. I. GROSSWEINER. Letter in *J. chem. Phys.*, **21**, 372–3 (*Feb.*, 1953).

Excitation of ice at 90°K by X-rays is followed on warming in the dark by a thermal glow with a maximum at 158°K. The emission spectrum appears to be as already recorded [Abstr. 146 (1953)]. G. F. J. GARLICK

535.376

3176. Influence of electric fields on luminescence. F. MATOSSI AND S. NUDELMAN. Letter in *Phys. Rev.*, **89**, 660 (*Feb.* 1, 1953).

If a potential difference of 400 V at 10 000 c/s is applied to a phosphor film (ZnS.Cu) excited with near u.v. the signal received on an oscilloscope coupled to a photomultiplier exposed to the phosphor shows a sudden extinction effect at onset of field and an increase on cessation. The extinguishing effect increases with frequency and field strength. With a fast sweep rate a momentary flash up is detected at onset of field and the trace shows a ripple of twice the field frequency. J. EWLES

535.39 : 531.715.1

3177. On the choice of measurements to be made for simultaneous determination of the optical constants and thickness of thin absorbing films. D. MALÉ. *C.R. Acad. Sci.* [*Paris*] **235**, 1630–1 (*Dec.* 22, 1952) *In French.*

An approximation formerly proposed by H. Wolter relating reflectivities, absorptions and transmission for thin films is re-examined graphically. Using existing experimental data it is confirmed that the Wolter relation holds for thickness less than 0·027 of the wavelength of the light used. Further in the region of optical constants for Ag in the visible the relation holds whatever the thickness. The method described enables constants and thickness to be obtained with only three measurements. S. TOLANSKY

535.417

3178. Direct method of measurement of the characteristics of a Fabry–Pérot interference system. P. GIACOMO. *C.R. Acad. Sci.* [*Paris*] **235**, 1627–9 (*Dec.* 22, 1952) *In French.*

The mean transmission factor of an interferometer is a function of $1 - R$, where R is the coeff. of reflection of one surface. This factor is measured directly by comparing the illumination on a photocell with and without the interferometer interposed. Results obtained for layers of cryolite and ZnS, each $\lambda/4$ thick, are in good agreement with those calculated from classical Fresnel theory. N. CORCORAN

535.417

3179. Very accurate measurement of fringe shifts in an optical interferometer study of gas flow. F. D. Werner and B. M. Leadon. *Rev. sci. Instrum.*, **24**, 121–4 (*Feb.*, 1953).

A new means of measuring fringe shifts for certain types of interferograms has been devised, and experimental tests indicate that accuracy of better than one five-hundredth of the fringe separation is possible. The method and tests of its accuracy for a simple case of parallel fringes are described. The method eliminates concern over refraction effects in interferograms of a class of gas flows. Among certain measurements with the interferometer which are expected to be greatly facilitated by use of this technique, is the measurement of the density distribution within a low density shock wave front. Some other applications are suggested. A.

535.417 : 533.6.07

3180. Theory of the Erdmann interferometer for investigation of compressible flows. A. I. van de Vooren. *Appl. sci. Res.*, *B*, **3**, *No.* 1, 18–28 (1952).

See Abstr. 221 (1952). A theory is developed which allows the calculation of the intensity at the image when phase differences at the object are made visible by the field-absorption method. The resulting formulae have been applied to some particular density fields (differences in phase being proportional to differences in density), viz. to a rectangular object of constant density, a similar object with linearly increasing density and a square object with linearly increasing density along a diagonal. The narrow interference slit is assumed to be infinitely long and is perpendicular to the gradient of the density for the examples presented. The results are in excellent agreement with experiments and confirm that the optical distance between the dark lines at the image corresponds to one wavelength at the object. A.

535.42

3181. Random circular gratings. L. Ronchi, G. Toraldo Di Francia and M. T. Zoli. *Atti Fond. Ronchi*, **6**, 317–25 (*Dec.*, 1951) *In Italian.*

The problem investigated concerns the diffraction of light through many apertures located at random on a plane screen. Starting from the distribution function of the complex amplitude, the probability distribution is evaluated for the real amplitude as well as for the illumination; and a simple formula derived for the mean illumination. The results are applied to the particular case of the circular grating with random radii. The theoretical predictions have been qualitatively verified by an experiment. A.

535.42

3182. New super-resolving pupils. G. Toraldo Di Francia. *Atti Fond. Ronchi*, **7**, 366–72 (*Nov.–Dec.*, 1952) *In Italian.*

In another paper (*Nuovo Cimento*, not yet published) some super-resolving pupils are considered, consisting of several concentric rings of negligible width. The present paper investigates the case where the rings, instead of being infinitely thin, have a finite width and on the whole occupy all the area of the pupil. In this manner no more light is wasted than is necessary for obtaining the super-resolving property. A.

535.42

3183. Contribution to the theoretical study of the diffraction pattern given by a circular aperture half covered by a plane parallel plate. N. Ségard. *C.R. Acad. Sci.* [*Paris*] **235**, 1496–8 (*Dec.* 10, 1952) *In French.*

An extension of an earlier discussion employing Fresnel construction [Abstr. 3497 (1952)]. Rigorous solution, involving a Bessel function, is laborious. It is shown how a simple convergence can be developed which enables rapid tabulation of the Bessel function. S. Tolansky

535.42 : 517.512.4

3184. The X_n and Y_n functions of Hopkins, occurring in the theory of diffraction. E. Wolf. Letter in *J. Opt. Soc. Amer.*, **43**, 218 (*March*, 1953).

It is shown that the "multiplication" theorems of Boivin [Abstr. 2649 (1952)] can be simplified by means of expressions for the X_n and Y_n functions in terms of the Lommel functions U_n and V_n, which have been given by Wolf [Abstr. 1773 (1951)]. The results greatly simplify numerical computation. H. H. Hopkins

535.43

3185. On the theory of scattering of light in isotropic media. L. M. Biberman. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7), 124–5 (1952) *In Russian.*

Sobolev (1951) proposed a new method in the theory of light scattering, which permits one to reduce the problems due to various positions of the source to only one integral equation, a solution for which exists in the literature. Sobolev's result is substantiated, and it is shown that it can be obtained by a different method. E. Rabkin

535.435

3186. An important reflectance correction in light-scattering studies. H. Sheffer and J. C. Hyde. *Canad. J. Chem.*, **30**, 817–20 (*Oct.*, 1952).

Light transmitted through the scattering cell and reflected backwards at the exit surface will cause an error in scattering measurements, amounting to about 27% in a polystyrene specimen. Corrections may be calculated; or the error may be eliminated by cementing a prism to the exit face of the cell. The two methods are shown to give consistent results. G. F. Lothian

535.435

3187. Light scattering by very stiff chain molecules. A. Peterlin. Letter in *Nature* [*London*], **171**, 259–60 (*Feb.* 7, 1953).

The angular distributions of scattered light for various values of stiffness, regarded as the ratio projected/total chain length, are calculated and compared with measurements on thymonucleic acids. G. F. Lothian

535.435 : 535.51 : 532.7

3188. An experimental investigation of the dependence of the intensity of the polarized components of Rayleigh scattering of liquids on temperature. M. F. Vuks and I. I. Bilenko. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7), 105–14 (1952) *In Russian.*

The intensities of the two polarized components of scattered light in a number of liquids were measured. The scattered ray, which is at 90° to the incident, is

resolved into two polarized components, one with the electrical vector parallel to, and the other with the electrical vector perpendicular to the incident ray. The intensity of each component was investigated individually. The first component will depend only on the anisotropic scattering, and the second on the anisotropic together with the isotropic. The liquids, chosen partly because X-ray data on their structure existed, were investigated in groups as follows: benzene, which was used as a standard, paradichlorbenzene, paradibrombenzene, paradi-iodobenzene, naphthalene and diphenyl; chlorbenzene, brombenzene and iodobenzene; chloroform and bromoform; formic, acetic and butyric acids; phenylsalicylate, benzophenone, phenol and nitrobenzene. The temperature dependence of the anisotropic portion of the Rayleigh scattering can increase or decrease with temperature. Related liquids give similar anisotropic and isotropic scattering. It is assumed that this is due to the similar packing of the molecules in the liquids. E. RABKIN

535.51

3189. Demonstrations with half-wave plates. J. G. WINANS. *Amer. J. Phys.*, **21**, 170–9 (*March*, 1953).

Cellophane of thickness to give 180° phase difference between *O* and *E* beams may be combined with polarizing sheets to make three types of windows. A design is cut in the Cellophane and it is mounted on the polarizer with effective optic axis 45° to the plane of vibration transmitted. The three types are (*a*) linear polarizer with half-wave Cellophane, (*b*) linear/circular polarizer with half-wave Cellophane mounted on the side opposite the quarter-wave plate, (*c*) linear/circular polarizer with half-wave Cellophane mounted on the same side as the quarter-wave plate. Two windows of type (*a*) give eight different patterns depending on the arrangement. One window of type (*a*) permits detection of small degrees of polarization. With one window of type (*b*) and one of type (*c*) there are six possible patterns, two of which do not change with rotation of one window with respect to the other. These effects result from the ability of a half-wave plate to rotate the plane of vibration through any angle or reverse the sense of circularly polarized light. A.

535.542.1

3190. The examination and calibration of Soleil compensators. H. G. JERRARD. *J. sci. Instrum.*, **30**, 65–70 (*March*, 1953).

Some possible errors in the construction of the Soleil type of compensator are given. The effects of these errors are discussed from the point of view of their detection. Full experimental details, and the necessary theory, are given of the various optical methods used in examining a compensator. The method of calibration with and without a half-shadow device is described. A.

535.547

3191. Transmission-like reflexion fringes in birefringent crystals. A. R. VERMA. Letter in *Nature* [*London*] **171**, 396 (*Feb.* 28, 1953).

It is known that if the first reflected beam in multiple beam interference reflected fringes is cut out then the reflected pattern inverts to the appearance of the corresponding transmitted pattern. By placing a birefringent crystal between silvered surfaces and illuminating in reflection with plane polarized light the analyser can cut out the first beam. S. TOLANSKY

535.55

3192. Determination of the photoelastic constants p and q of optical glasses. C. SCHAEFER AND H. NASSENSTEIN. *Z. Naturforsch.*, **8a**, 90–6 (*Jan.*, 1953) *In German.*

154 glasses were investigated at 5180Å. The range of variation was $0{\cdot}113 < qn/c < 0{\cdot}450$, $0{\cdot}170 < pn/c < 0{\cdot}391$, n being the refractive index and c the velocity in a vacuum. With increasing n both ratios showed a general tendency to increase while the difference $[(p-q)n/c]$ decreased and actually became negative for a glass with $n = 1{\cdot}94$. The "dispersion" in p and q between 4630 Å and 5940 Å was small and the largest value found for the change within this range was $\sim 0{\cdot}020c$ for both p and q. R. O. DAVIES

535.55

3193. The determination of the ratio p/q of the photoelastic constants of optical glasses by a dynamic method. C. SCHAEFER AND K. DRANSFELD. *Z. Naturforsch.*, **8a**, 96–9 (*Jan.*, 1953) *In German.*

The ratios are tabulated for about 150 Schott glasses. The method using high frequency vibrations [H. Mueller (1938)] and fully described by Schaefer and Bergmann [Abstr. 5343 (1950)] was used. Comparison is made with the ratios found by Schaefer and Nassenstein (preceding abstract) using a static method. The tables show agreement to within ± 10% and the experimental error of each method is estimated at ± 5%. It is concluded, however, that the dynamic values are about 1·5% higher than the static. The dependency of the ratio on density, temperature and wavelength of the light used is discussed. H. G. JERRARD

535.58

3194. On the question of the time of relaxation of the electrical double refraction of liquids. V. A. MARININ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 34–9 (1952) *In Russian.*

With the aid of a stroboscopic method the electrical double refraction of mixtures of nitrobenzene and orthonitrotoluene with mineral oil and benzene was investigated. For such mixtures the dielectric constant was measured and its dependence on temperature (viscosity) was observed. Experiment showed that the time of relaxation is equal to or less than 2×10^{-9} sec. This value is found to be in sufficiently good agreement with that calculated from data obtained by other experimental methods. W. BARDSLEY

535.65

3195. Colorimetric specifications of Munsell repaints. D. NICKERSON, J. TOMASZEWSKI AND T. F. BOYD. *J. Opt. Soc. Amer.*, **43**, 163–71 (*March*, 1953).

A table of C.I.E. tristimulus values and chromaticity co-ordinates, and Munsell renotations is provided for repaints of all regular Munsell standard papers made up to July, 1950, that have not been reported pre-

viously. The colorimetric data were calculated from spectrophotometric measurements. A.

535.65

3196. Dye control with the *R*-Cam and ruler. B. S. PRITCHARD AND E. I. STEARNS. *J. Opt. Soc. Amer.*, **43**, 212 (*March*, 1953).

See Abstr. 169 (1953). Acknowledgment of priority.

535.65 : 535.89

3197. Spectral energy distribution of the international commission on illumination light sources *A*, *B*, and *C*. R. DAVIS, K. S. GIBSON AND G. W. HAUPT. *J. Opt. Soc. Amer.*, **43**, 172–6 (*March*, 1953).

Standard light sources *A*, *B* and *C* were adopted by the International Commission on Illumination (C.I.E.) in 1931 for the colorimetry of materials. Source *A* is an incandescent lamp operated at 2854°K. Sources *B* and *C*, representative of average noon sunlight and average daylight, respectively, are produced by passing radiant flux from source *A* through specified Davis–Gibson filters described in Bureau of Standards Miscellaneous Publication M114 (1931). The C.I.E. published relative energy data only from 370 to 720 mμ. The present paper gives data for these sources in the u.v. and extends the data in the red to 780 mμ. A.

535.822.9

3198. A new method of light microscopy. A. WILSKA. Letter in *Nature* [*London*] **171**, 353 (*Feb.* 21, 1953).

Using annular apertures made in a thin layer of candle soot on a microscope objective lens and corresponding apertures in the condenser, an ordinary microscope can be made suitable for the study of unstained specimens. Two different procedures are described. R. W. FISH

535.822.9

3199. Phase contrast and contrast by interference [Contraste de phase et contraste par interference]. Edited by M. FRANÇON. *Paris: Editions "Revue d'Optique"* (1952) 264 *pp.*

Proceedings of the Colloquium of the Commission Internationale d'Optique held at Institut d'Optique, Paris, in May, 1951. Twenty-nine articles. For abstracts see abstracts following. R. W. FISH

535.822.9

3200. The interference microscope. J. DYSON. "*Phase contrast*" *symposium*, 35–41 [see Abstr. 3199 953)] *In French.*

The contrast in the image is obtained by superimposing two coherent fields, one with, the other without the object. The main advantages are the absence of the diffraction fringes around the image found in phase contrast microscopy and the unblocked exit pupil. R. W. FISH

535.822.9

3201. Some new forms of interference microscope. J. ST. L. PHILPOT. "*Phase contrast*" *symposium*, 42–7 [see Abstr. 3199 (1953)].

In a double-beam interference microscope the two beams may be represented by O and TOT^{-1}, where O represents the effect of the phase object and T, T^{-1} represent an optical transformation and its reciprocal. If the phase is adjusted to give a black background, the recombined beams give $(O - TOT^{-1}) = (OT - TO)T^{-1}$. The object is therefore visible against the black background if T and O do not commute; and the nearer the comparison object TOT^{-1} is to 1 (the unmodified beam), the more accurately will the object O be seen as an intensity transform of the phase pattern. The operator T may represent an axial or transverse shift, an axial rotation through 180°, transverse reflection, or blurring by aberration. With axial shift or with aberration TOT^{-1} approaches 1 by averaging over O. In the other cases $TOT^{-1} = 1$ wherever a gap occurs in O, but generally there is confusion from overlapping images unless the shift is right out of the field to a second objective trained on a dummy object. Experiments are described with some of the above forms of T, using partial reflection or polarization for beam splitting. The "crystalentic" microscope uses polarization and produces axial shift or aberration by means of double-focus crystalline lenses. It is probably the most practical. A.

535.822.9

3202. Comparative theoretical study of phase-contrast and interference methods. M. FRANÇON. "*Phase contrast*" *symposium*, 48–55 [see Abstr. 3199 (1953)] *In French.*

Phase plates with high reflection coefficients (multiple coatings) are necessary if the interference method is to have the same sensitivity as the phase contrast method. A transmission phase plate of density 3 is easy to make while the reflection plate with reflection coefficient 0·98, which has the same sensitivity, is very difficult to make. The observation of large objects is however easy by interference methods and very difficult by phase contrast. A.

535.822.9

3203. A comprehensive vector theory of phase-contrast and interference contrast. R. BARER. "*Phase contrast*" *symposium*, 56–64 [see Abstr. 3199 (1953)].

Although the mathematical theory of phase contrast is very complex, simplifying assumptions are usually made in order to obtain formulae which can be conveniently handled. Such mathematical simplifications usually imply physical conditions rarely found in practice, such as the use of a point source and point phase plate. If, on the other hand, one starts with the simplified physical assumptions, it is possible to develop a vector representation which describes very clearly the behaviour of a refractive absorbing object when viewed by any type of phase contrast. From this geometrical representation, it is possible to derive formulae which are identical with those derived by means of difficult mathematical procedures. The same type of vector analysis can be applied in interference contrast and the close interrelationship between the two methods becomes obvious. Formulae are developed which relate the phase-change and absorption of the phase plate to the path difference and intensity ratio of the interfering fields. It is shown that certain desirable conditions, which are difficult to obtain by phase contrast are very easily achieved by interference contrast. A.

535.822.9

3204. The simultaneous use of multiple beam interference and phase contrast in the study of transparent and reflecting "phase objects." G. NOMARSKI. "*Phase contrast*" *symposium*, 65–86 [see Abstr. 3199 (1953)] *In French.*

The method of Zernicke, although very sensitive for small phase differences, is not suitable when an object possesses large phase differences. The method of multiple beam interference, on the other hand, is not effective for very small phase differences. The author proposes the simultaneous use of both methods. Sample photographs are shown.

R. W. FISH

535.822.9

3205. A theoretical investigation of the phase contrast image of a single isolated continuous irregularity. J. V. RAMSAY. "*Phase contrast*" *symposium*, 89–98 [see Abstr. 3199 (1953)].

In most discussions of phase contrast a grating is used as an object. The treatment given here considers the case of an isolated continuous irregularity. It is shown that the amplitude in the image plane can be expressed as the sum of four integrals. These show the effects of the following factors: the finite aperture of the system and the phase disk, the aberrations of the illuminating wave and the imaging lens, and the constants of the phase disk. Numerical results are shown for the case of an aberration-free system. These give the visible range of the diameter of the irregularities, the variation of intensity with their height, the correspondence of object and image, and the effects of variations in the constants of the phase disk. A.

535.822.9

3206. The resolving power of the phase-contrast microscope. M. FRANÇON AND A. SAEZ. "*Phase contrast*" *symposium*, 98–108 [see Abstr. 3199 (1953)] *In French.*

The resolving power of a phase contrast microscope using an annular phase plate is studied. The surface of the phase plate is constant and the resolving power is studied as a function of the position of the plate in the pupil. The further the phase ring is from the axis, the better is the resolving power. In phase contrast microscopy a slightly better resolving power can be obtained than in ordinary microscopy. This is largely due to the modification of the diffraction structure in the presence of the coherent background from an oblique source. A.

535.822.9

3207. The properties of an interference filter of the Fabry–Pérot type used as a phase plate. C. DUFOUR. "*Phase contrast*" *symposium*, 108–14 [see Abstr. 3199 (1953)] *In French.*

A sharp maximum or minimum of transmission in an interference system goes with a sharp phase variation for the transmitted beam. The author gives the conditions which are necessary in a phase plate made of an interference filter (silver dielectric type) for obtaining a phase shift from $\pi/2$ to $3\pi/2$ when λ goes through λ_0, a sharp maximum or minimum of transmission. An elementary theory gives the order of the effect; the elements of a complete theory are given. A.

535.822.9

3208. Phase contrast with interference filters. M. LOCQUIN. "*Phase contrast*" *symposium*, 114–22 [see Abstr. 3199 (1953)] *In French.*

The working of the system described in the preceding abstract is described. Images are compared with those given by the classical Zernicke phase contrast and the variable phase contrast with polarized light due to the author. The improvement in the quality of the image enables the system to be used with very high magnifications, where the classical phase contrast would be useless. A.

535.822.9

3209. A variable phase-contrast microscope (Françon-Nomarski system). J. LAMARCHE. "*Phase contrast*" *symposium*, 122–4 [see Abstr. 3199 (1953)] *In French.*

The microscope uses a reflecting eyepiece attachment to give variable phase contrast. Practical details are given. R. W. FISH

535.822.9

3210. Phase-contrast equipment for use with the Cooke ultra-violet microscope. B. O. PAYNE. "*Phase contrast*" *symposium*, 124–30 [see Abstr. 3199 (1953)].

The equipment has been designed to fulfil a dual purpose. Firstly, to enable the specimen to be examined under phase contrast in visible light for searching and, secondly, to enable the phase contrast method to be applied to the u.v. microscope. A.

535.822.9

3211. A re-imaging attachment for use in phase-contrast microscopy. B. O. PAYNE. "*Phase contrast*" *symposium*, 130–3 [see Abstr. 3199 (1953)].

It is an advantage to have the back principal focal plane of the objective accessible, so that phase plates, etc., can be introduced or exchanged without removing the objective. A system is described in which a concave mirror is used to re-image this focal plane at a convenient position. R. W. FISH

535.822.9

3212. Infrared phase-contrast microscopy. R. BARER. "*Phase contrast*" *symposium*, 133–5 [see Abstr. 3199 (1953)].

The infrared image is made visible on a fluorescent screen which can be observed or photographed. Phase contrast objectives have been specially designed for i.r., but ordinary phase contrast objectives can be used without difficulty. Although resolving power is decreased, observation with i.r. is sometimes advantageous, especially for the examination of objects opaque in visible light, but transparent in i.r. A.

535.822.9

3213. Phase plates by reflection. M. FRANÇON AND G. NOMARSKI. "*Phase contrast*" *symposium*, 136–41 [see Abstr. 3199 (1953)] *In French.*

Phase plates by reflection were introduced in 1949. The phase difference between the direct and the diffracted light is obtained by reflection and not by transmission as in ordinary phase plates. With these plates it is easy to obtain both variable absorption and variable phase. A.

535.822.9

3214. Phase structures seen in the ordinary microscope. H. H. HOPKINS. "*Phase contrast*" *symposium*, 142–52 [see Abstr. 3199 (1953)].

When the illuminating aperture is small compared with that of the objective, the object viewed by a microscope may be regarded as coherently illuminated. Under these conditions a structure such as a "step" in a crystal face will diffract light outside the aperture of the objective, and for this reason some evidence of the presence of the structure should be seen in the image. The diffraction images of vertical "steps," of a circular plateau and of a narrow ridge, have been calculated. Curves are given showing the expected appearances of the images. A.

535.822.9

3215. The micro optical examination of metal surfaces turned by diamond tools. S. TOLANSKY. "*Phase contrast*" *symposium*, 155–63 [see Abstr. 3199 (1953)].

A description is given of the application of multiple beam interference methods to the examination of the fine structure of machined metal surfaces. The familiar light-slit microscope technique of Schmaltz is considerably extended and by its means profile and length magnifications of $\times 2000$ can quite easily be measured. The light slit is calibrated by interference fringes. A.

535.822.9

3216. Experimental investigation of the structure of transparent glass surfaces using phase-contrast illumination. L. C. MARTIN AND J. V. RAMSAY. "*Phase contrast*" *symposium*, 164–71 [see Abstr. 3199 (1953)].

A phase contrast apparatus using reflected light is described. With this arrangement isolated transparent surfaces can be examined. Details of the method of isolating one surface are discussed. The phase disk is made from aluminium and cryolite and introduces a phase retardation of approximately $\pi/2$ radians. The physical size of the phase disk is also discussed. An annular diaphragm has been used to isolate certain frequencies of the irregularity. The surfaces investigated are polished glass surfaces, and particular attention is paid to the polish marks. Photographs have been obtained showing the effect of variations in the angular size of the phase disk. A.

535.822.9

3217. Application of phase contrast to the study of small polishing defects of optical surfaces formed by different techniques. J. TEXEREAU. "*Phase contrast*" *symposium*, 172–85 [see Abstr. 3199 (1953)] *In French.*

The Lyot phase contrast method shows polishing defects which are almost completely unseen with other methods, in spite of the diffracted parasitic light. The width of these faults is generally between 0·1 and 2 mm and their depth about 10 Å, so that their slope is small, as for other defects, and depends chiefly upon the polishing method. Comparisons of results obtained with different polishers, polishing powders and working methods are given. A.

535.822.9

3218. Phase plate in the form of a narrow strip, its properties and applications. G. NOMARSKI. "*Phase contrast*" *symposium*, 185–96 [see Abstr. 3199 (1953)] *In French.*

A linear phase plate is placed in the circular pupil of the objective. Curves are obtained for a line object with both a point source and a source filling the phase plate. The imagery of the line object is shown to be more faithful with a linear phase plate than with the usual annular plate. R. W. FISH

535.822.9

3219. Phase-contrast and interference microscopy of birefringent objects. R. BARER. "*Phase contrast*" *symposium*, 196–203 [see Abstr. 3199 (1953)].

Since both phase contrast and interference microscopy are essentially methods of micro-refractometry, it is clear that a birefringent object will in general produce a confused image unless plane polarized light is used. The appearance of the object will then vary with the plane of polarization. If a birefringent object is mounted in a medium of refractive index equal to that of the maximum or minimum refractive index exhibited by the object, the latter will appear with maximum contrast for one direction of polarization and should be virtually invisible when the polarizer is rotated by 90°. Since phase contrast microscopy is capable of detecting phase changes of the order of $\lambda/100$ or less, it is clear that birefringence of this order which occurs in biological objects can also be detected. Experiments are described with objects which are virtually invisible by either phase contrast or interference contrast unless polarized light is used. A.

535.822.9

3220. The control of grating quality by phase contrast. A. MARÉCHAL. "*Phase contrast*" *symposium*, 204–8 [see Abstr. 3199 (1953)] *In French.*

Phase contrast technique offers the possibility of detecting slight deformations in a wave front: one can use it for testing the wavefronts diffracted by gratings, in order to detect slight phase errors related to defects of position of the grooves. Thanks to its high sensitivity the method can be used even for very high quality gratings, where ghost intensities are practically negligible. A.

535.822.9

3221. Analysis by phase contrast of the simple and complex periodicities of gratings. E. INGELSTAM. "*Phase contrast*" *symposium*, 209–17 [see Abstr. 3199 (1953)] *In French.*

The study of periodic errors in ruled optical gratings, begun by Camus, Françon, Ingelstam and Maréchal, is now being continued more quantitatively. The receiver is a photomultiplier tube, a second tube being used as a reference for the lamp flux. The current from both the phototubes is registered by a recorder. Reference phase contrast strips have been used as standards for the contrast scales. Fourier analysis of the records are made, and thus periodicities may be separated from random irregularities. A.

535.822.9

3222. Application of phase contrast to the determination of small differences of refractive index in liquids. E. INGELSTAM. "*Phase contrast*" *symposium*, 217–23 [see Abstr. 3199 (1953)] *In French.*

In preliminary studies on the measurement of small (down to 10^{-7}) differences in the refractive

indices of fluids, the reference fluids have been placed in a plane-parallel space between two plano-convex lenses of good homogeneity and smooth polish, forming the lens system. The fluid with which the comparison is to be made is either forced into the reference fluid, or is contained in a small cell in its central part. For calibration, reference striae or spots of magnesium fluoride are evaporated on to the outside of the lenses. A proposed subject for discussion is the application of the phase contrast method to the phase gradients often encountered in the study of fluids. A.

535.822.9

3223. Application of variable contrast methods to the study of aerodynamic fields. E. INGELSTAM. "*Phase contrast*" *symposium*, 223–6 [see Abstr. 3199 (1953)] *In French.*

In some applications, such as the examination of aerodynamic fields, it may be of advantage to increase the intensity of the central diffraction spot on the phase plate, with respect to that of the light falling on its outer parts. This procedure, which can in such cases improve the contrast, is the opposite of the usual method in which improved contrast for very small phase differences is wanted. A continuous variation of the wanted attenuation is achieved by a phase mirror similar in type to that of Françon and Nomarski. Problems and possibilities in the evaluation of phase contrast images of aerodynamic fields are discussed. A.

535.822.9

3224. The measurement of unresolved opaque particles by means of variable phase microscopy. H. OSTERBERG. "*Phase contrast*" *symposium*, 227–34 [see Abstr. 3199 (1953)].

A variable phase contrast method for measuring opaque particles smaller in size than the resolving power of the microscope is given. The phase change and the absorption of the phase plate are varied until the central pattern of the image vanishes. Formulae are given from which the particle size can then be determined. R. W. FISH

535.822.9

3225. On the increase of contrast by means of the sensitive color. H. KUBOTA. "*Phase contrast*" *symposium*, 234–7 [see Abstr. 3199 (1953)].

If a birefringent object is observed in polarized light by sensitive purple, the precision with parallel nicols is shown to be twice that with crossed nicols. A.

535.822.9

3226. Phase-contrast microscopy applied to cytology. A comparison of techniques and apparatus. M. BESSIS AND M. LOCQUIN. "*Phase contrast*" *symposium*, 237–58 [see Abstr. 3199 (1953)] *In French.*

Phase contrast has particular applications to the experimental study of living cells, making easier the counting of elements and the perception of fixed objects. The contrast of intra-cellular organites depends upon the compression of the cell and the spreading of some of them is a very interesting method of study. The results with classical objectives, with phase plates of different absorption and phase shift are compared with the results given by variable absorption and phase shift. 34 references. A.

535.822.9

3227. Observation and photography of ciliary infusoria in phase contrast. J. DRAGESCO. "*Phase contrast*" *symposium*, 258–61 [see Abstr. 3199 (1953)] *In French.*

535.822.9

3228. Difficulties in the observation in phase contrast of microscopic preparations of living objects. P. MANIGAULT. "*Phase contrast*" *symposium*, 261–4 [see Abstr. 3199 (1953)] *In French.*

The essential difficulties are (*a*) the finding of media with a variety of refractive indices in which the survival of the organism is possible, (*b*) the use of a compression technique immobilizing the subject sufficiently to allow observation, without spoiling the natural structure, (*c*) the photographic recording of the images during the observation. A method is described, using an electronic flash tube, whereby photographs may be recorded at a rate of 4 or 5 a minute. R. W. FISH

HEAT 536

536.21

3229. Thermal conductivity of frozen soil. A. HIGASHI. *J. Fac. Sci. Hokkaidô Univ. II*, **4**, 95–106 (*March*, 1952).

The thermal diffusivity of frozen soil was measured with the samples which were artificially prepared under the conditions similar to the natural frost formation. Thermal conductivity was computed from the diffusivity thus obtained and the volume specific heat of the soil. Moisture relationship of the thermal diffusivity k and the thermal conductivity K is represented by the following empirical formulae: $k = ae^{br}$, $K = ce^{dr}$. In these formulae, r is the moisture ratio of frozen soil and a, b, c and d are constants. These formulae hold only in the range of moisture content below the saturation moisture ratio. Two modes of segregation of ice are usually observed in the frozen soil: an ice plate of considerable thickness and a dispersion of innumerable thin layers. The soil samples of these two types of freezing contain usually more water than the saturation amount. In these cases the rate of increase of k with respect to r is smaller than that expressed by the former empirical formula. The variation of the thermal diffusivity in relation to the direction of heat flow is comparatively small. A.

536.23 : 536.7 : 531.19

3230. On the theory of the thermal conductivity of gases. J. MEIXNER. *Z. Naturforsch.*, **8a**, 69–73 (*Jan.*, 1953) *In German.*

The methods of the thermodynamics of irreversible processes are used to derive Eucken's formula for the thermal conductivity of polyatomic gases in the form given to it by Chapman and Cowling and by Schaefer. It is essential for the argument to consider the mutual diffusion of molecules in different states of excitation. The coefficients in the modified Eucken formula have a simple interpretation only in specially simple cases. E. H. SONDHEIMER

536.23 : 537.311.37 : 533.7

3231. Transport phenomena in a completely ionized gas. L. Spitzer, Jr and R. Harm. *Phys. Rev.*, **89**, 977–81 (*March* 1, 1953).

The coefficients of electrical and thermal conductivity have been computed for completely ionized gases with a wide variety of mean ionic charges. The effect of mutual electron encounters is considered as a problem of diffusion in velocity space, taking into account a term which previously had been neglected. The appropriate integro-differential equations are then solved numerically. The resultant conductivities are very close to the less extensive results obtained with the higher approximations on the Chapman–Cowling method, provided the Debye shielding distance is used as the cut-off in summing the effects of two-body encounters. A.

536.24

3232. Heat transfer to a boiling liquid. J. E. Rhodes, Jr. Letter in *Amer. J. Phys.*, **21**, 67–70 (*Jan.*, 1953).

Boiling at the surface of a warm body in a much cooler liquid is described in terms of two types of heat transfer. When the gas film is thin (low temperature difference) "contact" transfer takes place. If the thickness of the film is greater than the mean free path (high temperature differences) the transfer is explained in terms of accommodation coefficients. Figures are discussed for a conical copper body, fitted with a heating coil, when placed in liquid air. E. H. DOCK

536.24 : 539.217

3233. Numerical method for porous heat sources. P. J. Schneider. *J. appl. Phys.*, **24**, 271–3 (*March*, 1953).

An extension of the Emmons numerical method for temperature fields is developed for application in cases of solid-fluid heat transfer in which a gas or fluid passes through a porous wall generating non-uniform heat. The numerical approach is first presented in general form and then applied to the two specific cases of a porous power-producing cylindrical pipe and porous power-producing plain wall. A.

536.244

3234. Heat losses and their dependence on air velocity. D. G. Kapadnis and D. V. Gogate. *Indian J. Phys.*, **26**, 171–6 (*April*, 1952).

In this investigation, the variation of convective heat losses with different air velocities, for vessels of different shapes and sizes, has been studied. The rate of heat loss is found to depend upon the shape of the vessel used and varies directly as the square-root of the air velocity. A.

536.413 : 539.32

3235. Elasticity and thermal expansion of germanium between −195 and 275°C. M. E. Fine. *J. appl. Phys.*, **24**, 338–40 (*March*, 1953).

Young's moduli (E) of the directions ⟨100⟩ and ⟨111⟩ and the shear modulus (G) for ⟨100⟩ were determined in germanium from −195 to 255, 275 and 140°C, respectively. From these moduli, the elastic parameters, the compressibility and Poissons's ratio were calculated. The thermal expansion was measured from −196 to 275°C. A.

536.421.4–031

3236. The freezing of supercooled water in glass. R. G. Wylie. *Proc. Phys. Soc.* [*London*] *B*, **66**, 241–54 (*March*, 1953).

Gives an account of some experiments in which water was supercooled and frozen in glass. Elaborate precautions, which were taken to eliminate possible effects due to the colloidal matter of the atmosphere, permitted the study of freezing in an unusually simple environment. Comparison with the behaviour of water frozen in contact with the atmosphere allows some assessment of the significance of airborne contamination. The results, including those of some incidental experiments on the nucleating abilities of graphite, dust and the abrasion of glass on glass, are considered in relation to theory. It is found that the use of glass for the retaining surface precludes the study of spontaneous nucleation in the bulk of the water. A.

536.423

3237. Raoult's law: a pseudo-ideal system. A. Blackburn and J. J. Kipling. Letter in *Nature* [*London*] **171**, 174–5 (*Jan.* 24, 1953).

The measurement results of the total and partial vapour pressures of the system pyridine-ethanol approximate closely to the behaviour required by Raoult's law. F. LACHMAN

536.423.15

3238. The vapor pressure of germanium. A. W. Searcy. *J. Amer. Chem. Soc.*, **74**, 4789–91 (*Oct.* 5, 1952).

The vapour pressure of liquid Ge has been determined over a 370° range by the Knudsen effusion method. The data lead to the equation $\Delta F = 87\,490 + 2{\cdot}00T\ln T - 45{\cdot}5T$ for vaporization of liquid Ge. The vapour pressure results combined with estimated heat capacity and heat content data yield $84{\cdot}0 \pm 1{\cdot}5$ kcal. for the heat of sublimation of Ge at 298·15°K. Ge vapour is demonstrated to react with a heated Pt collector plate. A.

536.423.15

3239. Metal ebulliometers for vapour pressure measurement. G. D. Oliver and J. W. Grisard. *Rev. sci. Instrum.*, **24**, 204–6 (*March*, 1953).

Apparatus and methods are described for the measurement of the vapour pressure of materials, especially corrosive liquid, over the entire liquid range. The first method consisted of measuring the pressure registered on a mercury manometer by He, which acted as a buffer between the manometer and a single boiling-point tube. In the second method, two metal boiling-point tubes were connected to a common pressure system. The boiling temperature of the test liquid in one tube was compared directly with the boiling temperature of water in the other. Pressure values were interpolated from steam tables. The data obtained with both systems were compared with accepted data. A.

536.423.4 : 532.7 : 530.162

3240. Statistical mechanics of phase transition. S. Ono. *Progr. theor. Phys.*, **8**, 1–12 (*July*, 1952).

Mayer's theory of the relation between phase transitions and singular points has been criticized. The matrix method is connected with Mayer's cluster

theory applied to regular solutions. It is shown that the following two cases are possible. They are: (i) that the density of atoms is a single function of the active number density, at least, on the positive real axis, the first singularity of this function is an essential singular point and the phase transition occurs at this point; (ii) that the density of atoms may consist of different analytic functions of the active number density, and the phase transition may occur at a point which is not the analytic singular point of the function. The same is true of continuous aggregate systems such as imperfect gases. In the continuous case the partition function may be obtained as the smallest eigenvalue of Fredholm's integral equation. A.

536.424

3241. The effect of the rate of cooling on the allotropic transformation temperatures of uranium. P. Duwez. *J. appl. Phys.*, **24**, 152–6 (*Feb.*, 1953).

Allotropic transformation in U has been studied over a range of cooling rates from 5 to about 8000°c/sec. The transformation temperatures of both γ to β and β to α were found to decrease continuously with increasing rates of cooling. The extent of the β-range increased with increasing cooling rates. For rates of cooling up to 1000°c/sec, recalescence was observed in both transformations. For higher cooling rates, there was usually no recalescence. In most of the recorded cooling curves, a small but definite thermal arrest was observed, between the two main arrests which correspond to the two known phase transformations. This additional thermal arrest was also present in a heating curve, where it occurred at about 740°c, compared with 666 and 771°c for the two known phase transformations. Possible explanations of the additional arrest are discussed. A.

536.424 : 548.7

3242. An interpretation of the phase transitions in the solid hydrogen halides. J. G. Powles. *Rep. Brit. Elect. Res. Assoc., Ref. L/T259*, 12 *pp.* (1951).

Attempts to interpret the behaviour both with respect to the properties of the different phases and to the mechanism of the transitions. A summary of the relevant published experimental data is given, and models are proposed for the different phases which have properties in accord with the experimental data. A.

536.424 : 548.73

3243. On the Zr–Hf system. R. B. Russell. Letter in *J. appl. Phys.*, **24**, 232–3 (*Feb.*, 1953).

Disagreements in the literature [Abstr. 9243 (1951), 4305 (1952)] on some features of this system may be traced to a confusion, in reporting lattice parameter measurements, between Ångström and Siegbahn (kX) units. New parameter measurements are given for Zr, Hf and a few of their alloys which suggest a pos. deviation from Vegard's law at high Hf concentration. A. D. LE CLAIRE

536.44

3244. On the liquid-vapor coexistence curve of xenon in the region of the critical temperature. II. M. A. Weinberger, H. W. Habgood and W. G. Schneider. Note in *Canad. J. Chem.*, **30**, 815–16 (*Oct.*, 1952).

See Abstr. 6464 (1952). New isotherm measurements at T_c confirm that gravitational effects are capable of explaining the whole flat top width of the observed coexistence curves. R. O. DAVIES

536.44 : 533.12

3245. Density distributions in a vertical tube containing xenon near the critical temperature as measured by a radioactive tracer technique. M. A. Weinberger and W. G. Schneider. *Canad. J. Chem.*, **30**, 847–59 (*Nov.*, 1952).

The variation of density with height has been determined for Xe confined in a long vertical bomb under near critical conditions. The densities were deduced by means of radioactive tracer techniques. Radioactive Xe^{127} was added to ordinary Xe and counting rates (assumed proportional to local densities) were measured at various positions along the bomb. The observed density distributions can be entirely explained by the influence of gravity on the system; a comparison of the observed density distribution with that calculated using the measured PV isotherms for Xe shows satisfactory agreement. A.

536.46 : 535.343

3246. Studies of the explosive combustion of hydrocarbons by kinetic spectroscopy. I. Free radical absorption spectra in acetylene combustion. R. G. W. Norrish, G. Porter and B. A. Thrush. *Proc. Roy. Soc. A*, **226**, 165–83 (*Jan.* 22, 1953).

The explosive oxidation of acetylene, initiated homogeneously by the flash photolysis of a small quantity of nitrogen dioxide, has been investigated by flash spectroscopy. The absorption spectra of OH, CH, C_2 (singlet and triplet), C_3, CN and NH, a number of which have not previously been observed, are described, and the relative concentrations, at all times throughout the explosion, are given. Four stages have been distinguished in the explosive reaction: (1) an initial period during which only OH appears; (2) a rapid chain branching involving all the diatomic radicals; (3) further reaction, occurring only when oxygen is present in excess of equimolecular proportions, during which the OH concentration rises exponentially and the other radicals are totally consumed; (4) a relatively slow exponential decay of the excess radical concentration remaining after completion of stages 2 and 3. The duration of stage 1 is 0 to 3 min. In an equimolecular mixture at 20 mm total pressure, containing 1·5 mm NO_2, the durations of both stage 2 and stage 3 are approximately 10^{-4} sec and the half-life of OH in stage 4 is 0·28 sec. A preliminary interpretation of these changes and of the radical reactions is given. A.

536.46 : 541.127

3247. Burning velocity of ethylene oxide decomposition flames. R. Friedman and E. Burke. Letter in *J. chem. Phys.*, **21**, 165 (*Jan.*, 1953).

Burning velocities over the pressure range 0·5 to 1·5 atm. and temp. range 70–130°c were obtained from measurements of the flow velocity and area of a flat flame stabilized on a burner 10 cm dia. The burning velocity varies inversely as the 0·25 power of the pressure, and not as the inverse 0·50 power to be expected from static kinetic studies indicating a first-order reaction. At room temp. and atmospheric pressure, the burning velocity is 2·7 cm/sec; this

widely differs from an earlier value (12·5 cm/sec) obtained by Gerstein *et al.* (1952). A. SCHOFIELD

536.461 : 532.5

3248. The hydrodynamic stability of flame fronts. H. EINBINDER. *J. chem. Phys.*, **21**, 480–9 (*March*, 1953).

The hydrodynamic stability of a plane flame of finite thickness is treated by investigating the temporal behaviour of first-order infinitesimal disturbances. This work is a generalization of earlier studies and takes into account the effect of distortion on burning velocity. The general equations of motion for the disturbance in a viscous gas under the influence of gravity are derived and solved. Horizontal and upward propagating plane flames are always unstable and those propagating downward are unstable under most conditions, so their measured transformation velocity under such conditions does not equal the stationary burning velocity. The calculated maximum cell size for downward propagation ($\lambda_{max} = 32U_uU_b \times 10^{-4}$ cm) and the cell size for a flame propagated by thermal conduction ($\lambda_{thermal} = 22k/C_p\rho_uU_u$) are in good agreement with existing experimental observations. The variation of cell size with pressure yields the pressure dependence of the burning velocity. The sudden appearance of cells in slow hydrocarbon flames ($U_u \gtrsim 10$ cm/sec) observed at stoichiometric in going from lean to rich mixtures, indicating a corresponding decrease in flame thickness, is advanced as provisional evidence of a shift in the dominant propagation mechanism in these flames—from diffusion by atomic radicals for lean flames to thermal conduction for rich ones. A.

536.468

3249. Ignition of wood by radiation. H. P. STOUT; D. I. LAWSON AND D. L. SIMMS. Letters in *Brit. J. appl. Phys.*, **3**, 394–6 (*Dec.*, 1952).

Commenting on a recent paper by Lawson and Simms [Abstr. 8131 (1952)] Stout suggests that the ignition of wood by radiation is fundamentally similar to the ignition of gases by heated wires: a critical amount of energy being required, which is least when generated instantaneously in a small volume. In support of this suggestion it is pointed out that the quantity $(It)_o/\rho s$ is non-zero and almost constant over the wide variety of woods tested [$(It)_o$ being the limit of It as $t \to 0$, where I = radiation intensity, t = time delay before ignition, ρ = density of wood, s = spec. ht. of wood]. In reply Lawson and Simms present new data for large values of I (and hence small t) which show that $(It)_o = 0$; this is consistent with a theoretical prediction that if each species of wood ignites at a constant surface temperature, $(I\sqrt{t})_o/\rho s$ should be constant.

A. SCHOFIELD

536.48

3250. Molecular theory of the liquid helium λ point. I. PRIGOGINE AND J. PHILIPPOT. *Physica*, **18**, 729–48 (*Oct.*, 1952) *In French.*

A cell model is applied to liquid He. The volume of a cell is equal to the mean geometrical volume per molecule. Each cell may accommodate 0, 1 or 2 particles. The same model has been previously applied to classical liquids by Prigogine and Janssens (1950) and is a generalization of the well known Lennard–Jones, and Devonshire model of liquids. This model permits the fluctuations which occur in a classical liquid in the neighbourhood of the critical point to be taken into account. It is shown that due to the zero point energy and the corresponding dilatation of the cells, those fluctuations may occur in liquid He^4 long before the critical point. They depend strongly on the statistics of the particles. In the case of He^4 they give rise to a maximum of the specific heat in the neighbourhood of 2°K, in the case of the He^3 this effect is smeared out. This model permits both the interactions and the statistics of the particles to be taken into account. A.

536.48

3251. Normal fluid concentration in liquid helium II below 1°K. D. DE KLERK, R. P. HUDSON AND J. R. PELLAM. Letter in *Phys. Rev.*, **89**, 662 (*Feb.* 1, 1953).

This is calculated from specific heat data and the authors' results of the second sound velocity, disregarding the anomalous rise of the latter below 0·3°K [Abstr. 2421 (1953)]. On a log-log plot versus temperature the slope increases from 5·3 at the λ-point to about 13 at 0·7°K. It then decreases rapidly to the limiting value 4 below 0·5°K.

H. LONDON

536.48

3252. Properties of liquid helium 3. B. M. ABRAHAM, D. W. OSBORNE AND B. WEINSTOCK. *Science*, 1317, 121–6 (*Feb.* 6, 1953).

The [illegible] summarizes the low temperature research on liquid He^3, and its significance in the helium problem. 5 diagrams. R. B. DINGLE

536.48

3253. Vapor–liquid equilibria in He^3 — He^4 solutions. J. C. MORROW. *Phys. Rev.*, **89**, 1034–7 (*March* 1, 1953).

Recent measurements of the vapour pressures of He^3 — He^4 liquid solutions by Daunt and Heer and by Sommers are used to evaluate the solution non-ideality, for the calculation of which the large deviations of the vapour from ideality are taken into account. Estimation of the standard chemical potential of normal He^4 at temperatures below the λ-point is discussed. Agreement of excess chemical potentials of He^4 above the λ-point and the values obtained from the simple theory demonstrates the usefulness of the theory in discussions of effect of non-ideality on the shift of the λ-point with He^3 concentration.

3254. The entropy of liquid He^3. F. LONDON. *Phys. Rev.*, **89**, 1038–40 (*March* 1, 1953).

The vapour pressure of liquid He^3, compared with Abraham, Osborne and Weinstock, to a common temperature of the test directly with the other. Pressure following equation: $\log_{10}(P_{mm}$ tables. The data $1{\cdot}1561/T - 0{\cdot}25254T - 0{\cdot}00667$ 4 : 532.7 : 530.162 $0{\cdot}01210T^4$, up to 2·5°K. The en phase transition. liquid derived from this equation 12 (*July*, 1952). zero at 0°K, and in fact lies very clos on between phase curve for a Fermi–Dirac smoothe as been criticized. below 1°K. Hence the vapour pres th Mayer's cluster

no evidence for the existence of a transition below 1°K. A.

536.48

3255. On the hydrodynamics of non-viscous fluids and the theory of helium II. R. KRONIG AND A. THELLUNG. *Physica*, **18**, 749–61 (*Oct.*, 1952).

The classical hydrodynamics of non-viscous fluids for the case of irrotational motion and in the absence of external forces is represented in terms of general field theory. The velocity potential and the density appear then as canonically conjugate variables in a rigorous sense. A quantization is carried out along the usual lines, a number of results previously arrived at by Landau and his collaborators thus finding a full justification. In particular the concept of phonons becomes completely clarified. The energy and pressure of the fluid when thermally excited are discussed in view of applications to He II, use being made of considerations by Richter on sound pressure in liquids. A.

536.48

3256. Some questions in the hydrodynamics of helium II. É. L. ANDRONIKASHVILI. *Zh. eksper. teor. Fiz.*, **22**, No. 1, 62–5 (1952) *In Russian.*

Describes an experimental attempt to detect a superfluid ring or persistent current in He II. A system of closely spaced aluminium vanes contained in a cylindrical vessel is suspended in liquid He II from a torsion fibre and set into uniform rotation (0·5 revs/sec). The rotation is rather rapidly stopped and an attempt made to discover if the "superfluid" component continues to rotate, by suddenly heating the liquid He (from 1·5°K to 1·65°K), thus changing about 10% of the superfluid into normal fluid, which should then give its momentum to the can and produce a ballistic deflection. No effect greater than the experimental error was observed.

D. SHOENBERG

536.48

3257. Kinetic coefficients in helium II. I. M. KHALATNIKOV. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7), 8–20 (1952) *In Russian.*

Setting out from the kinetic equations for excitations in helium II the equations of motion of the liquid are derived. The kinetic coefficients for helium II are discussed and it is shown that there is a coefficient of first viscosity, three independent coefficients of second viscosity and a coefficient analogous to the coefficient of heat conductivity in ordinary bodies. General expressions for these coefficients are [illegible] D. SHOENBERG

4305 (1952)] ol 536.48

traced to a con**al conductivity and absorption of sound** measurements, b M. KHALATNIKOV. *Zh. eksper. teor.* units. New pa (7), 21–34 (1952) *In Russian.*

Zr, Hf and a fe**t of thermal conductivity** κ **introduced** deviation from V**aper (preceding abstract) is calculated**

nction of temperature and in terms

; Δ, p_0, μ specifying the excitation

3244. On the liqu. It is shown that because of the **in the region of th**ansion of He II, κ does not enter WEINBERGER, H. Won of first sound [thus leaving the Note in *Canad. J.*latnikov, Abstr. 6451 (1950), un-

See Abstr. 646uses an absorption of second sound larger than that previously calculated [Abstr. 6451 (1950)] due to viscous effects. Using more recent experimental data new values of Δ, p_0, μ are derived and the absorption coefficients of first and second sound are calculated numerically as functions of temperature [the results for first sound are not significantly different from those calculated previously, Abstr. 6451 (1950)]. It appears that for frequencies of order 10^4 c/s there should be an appreciable absorption of second sound. D. SHOENBERG

536.48

3259. Second-sound velocity below 1°K as a function of pressure. V. MAYPER, JR AND M. A. HERLIN. Letter in *Phys. Rev.*, **89**, 523 (*Jan.* 15, 1953).

At higher pressures the steep rise with falling temp. towards $\sim C_1/\sqrt{3}$ is shifted towards lower temperatures. The further increase towards the first sound velocity C_1 at the lowest temperatures [Abstr. 2421 (1953)] moves to higher temperatures, so that at the highest pressure (14·2 atm.) the two rises fuse together. The shape of the received pulse shows a steep rise with long tail at the lowest temperature and is more symmetrical and highly extended in the steep-rise-region. Gorter's explanation on the basis of the mean free path of the phonons [Abstr. 804 (1953)] which was originally intended to apply to the steep rise is now reserved for the lowest temperature region, whereas the broadening of the pulse in the former region is attributed to an interaction between the phonons with the higher-temperature exertations. H. LONDON

536.48

3260. Heat pulses in liquid He II below 1°K. K. R. ATKINS. Letter in *Phys. Rev.*, **89**, 529 (*Jan.* 15, 1953).

Discusses the propagation of heat pulses in liquid He II well below 1°K, assuming a long phonon mean free path. R. B. DINGLE

536.48

3261. Thermal Rayleigh disk measurements in He^3–He^4 mixtures. B. WEINSTOCK AND J. R. PELLAM. Letter in *Phys. Rev.*, **89**, 521 (*Jan.* 15, 1953).

In a mixture containing 4% He^3 the second sound velocity increases continuously with falling temp. to 38 m/sec at 0·9°K. This is in disagreement with Pomeranchuk's treatment [Abstr. 5399 (1949)] and in good agreement with Dingle's [Abstr. 969 (1952)]. The torque at 0·9°K is only a few tenth per cent of that of pure He^4. H. LONDON

536.483

3262. A laboratory plant for making liquid air from liquid oxygen. A. J. CROFT. *J. sci. Instrum.*, **30**, 74–6 (*March*, 1953).

Liquid oxygen, which is cheap and easy to get, will not do for certain purposes; in particular, a hydrogen liquefier needs liquid air for its pre-cooling bath. A small plant which produces 11 litres/hour is described; compressed air is condensed in a bath of liquid oxygen. A.

536.483 : 536.581.3

3263. A thermostat for the attainment of 50° abs. without the use of liquid hydrogen. E. JUSTI. *Z. Naturforsch.*, **7a**, 692–9 (*Oct.*, 1952) *In German.*

An 22–78% liquid nitrogen–oxygen mixture is used

as a eutectic mixture to obtain temperatures in the range 50°–80°K. An easily constructed all-metal cryostat is illustrated and described in detail. Such equipment has been used to determine the resistances of Ni wires of different purities in the range given above. E. H. DOCK

536.5.081

3264. The extension of the International Temperature Scale below the oxygen point. H. VAN DIJK. "*Maintenance of standards*" *symposium*, 51–8 [see Abstr. 2972 (1953)].

Recent measurements of the thermodynamic temperatures of the boiling points of H_2 and He and the several means, involving vapour pressure/temperature relations, calibrated resistance thermometers, gas thermometers calibrated at fixed points and the susceptibility/temperature relation of some paramagnetic salts, for the measurement of temperature between the secondary fixed points and below 4·2°K, are briefly described. The determination of the resistance/temperature relation for a pure metal and the deviations from this relation caused by small impurities or by internal stresses is dealt with in some detail and an interpolation formula is derived.

S. WEINTROUB

536.5.081

3265. Improvements in the realization of the International Temperature Scale over the range −182·97°C to 630·5°C. C. R. BARBER. "*Maintenance of standards*" *symposium*, 58–62 [see Abstr. 2972 (1953)].

In connection with the work in progress at the N.P.L. an account is given of a Pt resistance thermometer ($R_o \simeq 25\ \Omega$; $R_{100}/R_o > 1{\cdot}392$) of new design; a Smith bridge with specially wound manganin coils and without oil immersion; an intercomparison, using Pt resistance thermometers, of cells of different origin which gave values for the triple point of water (+0·0100°C) agreeing to within 0·0001°C; a new form of hypsometer, shown diagrammatically, for the determination of the steam and sulphur points; and an arrangement by which the barometer used for the steam and sulphur points can be applied to the oxygen vapour pressure thermometer.

S. WEINTROUB

536.587 : 621.317.733 : 621.316.7

3266. A wide range temperature controller using a resistance element. S. J. BORGARS. *J. sci. Instrum.*, **30**, 46–9 (*Feb.*, 1953).

The controller consists primarily of a high-gain amplifier with a resistive bridge feedback circuit, the sensitive element being one of the bridge arms. Under certain conditions of sense and degree of bridge unbalance, the circuit oscillates. The output is rectified and operates a relay which switches power to a control heater. The circuit sense is such that the mean temperature of the element is kept constant. Adjustment of the desired value is made by varying a bridge arm, which may be directly calibrated in units of temperature. The use of a thermistor for the resistance element enables a high sensitivity to be obtained, particularly at low temperatures. For operation at low temperatures, the ambient temperature of the controlled unit is maintained below the lowest temperature of control, thus operation can be effected by a supply of heat. A chamber of 570 in. was controlled to ± 0·09°C at −40°C. The intrinsic sensitivity is such that circuit operation will occur with a temperature differential of $< \pm 0{\cdot}01$°C. This could be improved by various circuit refinements.

A.

536.631

3267. Heat capacities at low temperatures and entropies at 298·16°K of orthotitanates of barium and strontium. S. S. TODD AND R. E. LORENSON. *J. Amer. Chem. Soc.*, **74**, 3764–5 (*Aug.* 5, 1952).

Heat-capacity measurements of crystalline barium and strontium orthotitanates and of their equimolal solid solution were conducted over the temperature range 51 to 309°K. The results are regular, except those for barium orthotitanate in the region above 268°K, where there is evidence of approach to a heat-capacity peak. The entropies at 298·16°K were obtained as 47·0 ± 0·5, 38·0 ± 0·3 and 45·8 ± 0·4 cal./deg. mole, respectively. A.

536.631

3268. Low temperature heat capacities and entropies at 298·16°K of magnesium orthotitanate and magnesium dititanate. S. S. TODD. *J. Amer. Chem. Soc.*, **74**, 4669–70 (*Sept.* 20, 1952).

Measurements were conducted throughout the temperature range from 50 to 298°K. The entropies at 298·16°K were found to be 24·76 ± 0·15 and 30·4 ± 0·2 cal./deg. mole. A.

536.631

3269. The specific heat of $CuCl_2 . 2H_2O$ between 1·5 and 20°K. S. A. FRIEDBERG. *Physica*, **18**, 714–22 (*Oct.*, 1952).

A λ-shaped peak is found in the C_p versus T-curve having its maximum at 4·31°K, the Néel temperature at which a transition occurs from the anti-ferromagnetic to the paramagnetic state. The total entropy change associated with this process is found to be 5·45 joules/deg. mol, approximately one-third of this being gained above the Néel point. Other characteristics of the anomalous peak are discussed.

A.

536.631 : 536.48

3270. The anomalous specific heat of ferrous ammonium sulphate. R. W. HILL AND P. L. SMITH. *Proc. Phys. Soc.* [*London*] *A*, **66**, 228–32 (*March*, 1953).

The specific heats of ferrous and zinc ammonium sulphates have been measured from 2 to 30°K; the difference between these gives the anomalous contribution of the ferrous ion. Two maxima are found in this latter quantity, these occurring at 3·8 and 20·3°K. A scheme of energy levels capable of explaining the anomaly is put forward and the question of its uniqueness discussed. A.

536.631 : 536.48

3271. T^2 dependence of the low temperature specific heat of gallium. W. DE SORBO. Letter in *J. chem. Phys.*, **21**, 168 (*Jan.*, 1953).

Using Adams's data (1952) it is shown that the specific heat obeys a T^2 law between 15° and 34°K.

C. TURNER

536.631 : 536.652

3272. The heat capacity of gallium from 15 to 320°K. The heat of fusion at the melting point. G. B. Adams, Jr, H. L. Johnston and E. C. Kerr. *J. Amer. Chem. Soc.*, **74**, 4784–7 (*Oct.* 5, 1952).

A gram atom of Ga (99·99% purity) was prepared and measurements were taken with this and four other samples, over the range 15 to 300°K, to obtain the heat capacity of the solid. The heat capacity of liquid Ga was measured from 303 to 322°K, and was found to decrease with increasing temperature over this range. The heat of fusion of a sample of pure Ga was measured in a calorimeter designed specifically for the purpose and was found to be 1335 ± 1·0 cal./g. atom. The entropy of fusion is 4·407 ± 0·004 e.u. at the melting point. A λ-point in the heat capacity curve for the solid observed at 292·4°K, was shown to have been caused by eutectic melting of Sn, present as an impurity in those samples for which the anomaly was observed. A table of thermodynamic functions has been prepared for Ga at smoothed values of the temperatures. The entropies at 298·16°K, and at the melting point, 302·94°K, are 9·82 ± 0·05 e.u. and 9·92 ± 0·05 e.u. (entropy of fusion not included), respectively, of which 0·15 e.u. was contributed by extrapolation below 16°K. A.

536.631 : 536.75

3273. The entropy and low temperature heat capacity of neptunium dioxide. E. F. Westrum, Jr, J. B. Hatcher and D. W. Osborne. *J. chem. Phys.*, **21**, 419–23 (*March*, 1953).

The heat capacity of a two-gram sample of neptunium dioxide was determined from 10 to 315°K in an adiabatic calorimeter. At 298·16°K the molal entropy and enthalpy calculated from the heat capacity data are 19·19 ± 0·1 cal deg^{-1} and 2770 ± 15 cal, respectively. A pronounced hump was found in the heat capacity curve of neptunium dioxide at 25·3°K similar to that found by Jones, Gordon and Long in uranium dioxide at 28·7°K. This anomaly in the heat capacity is suggestive of a co-operative phenomenon and is attributed to the incidence of antiferromagnetism below the temperature of the maximum in the heat capacity. A calorimeter for gram scale samples and a modification of the cryostat design of Ruehrwein and Huffman so as to employ only liquid helium and liquid nitrogen as refrigerants are described. A.

536.653

3274. Heat of solution of glasses, in particular of those of substances of high molecular weight [polymers]. E. Jenckel and K. Gorke. *Z. Naturforsch.*, **7a**, 630–2 (*Sept.*, 1952) *In German.*

The available results of measurements of the heat of solution of polystyrene in various solvents are in good agreement with the following reasoning: since a glass, when being dissolved, passes from the frozen condition into the melt equilibrium state, thus releasing the "freezing" heat, the heat of solution, as measured, must consist of this heat of freezing and of the heat of solution proper, the latter being equal to zero in the case of inert solvents. Consequently, the very high exothermic heat of solution of glasses with very large molecules ought to be explained not by the size of molecules but by the vitreous state. F. LACHMAN

536.655

3275. Investigation of the heat of vaporization of carbon. W. A. Chupka and M. G. Inghram. Letter in *J. chem. Phys.*, **21**, 371–2 (*Feb.*, 1953).

Describes preliminary measurements using a mass spectrometer technique to identify and measure the relative amounts of the various species evaporated from a graphite surface. The variation of C atom evaporation with temperature yields an apparent $\Delta H(0°K)$ of 178·5 ± 10 kcal/mole. The ratio C/C_2, assuming equal ionization cross-sections, was found to be 1·2 at 2300°K. F. LACHMAN

THERMODYNAMICS 536.7/.8

536.7

3276. Thermodynamics of some simple sulfur-containing molecules. W. H. Evans and D. D. Wagman. *J. Res. Nat. Bur. Stand.*, **49**, 141–8 (*Sept.*, 1952); with errata slip (*Oct.* 13, 1952).

The thermodynamic functions $(F° - H_0°)/T$, $(H° - H_0°)/T$, $S°$ $(H° - H_0°)$ and $C_p°$ are calculated to high temperatures for gaseous sulphur (monatomic and diatomic), sulphur monoxide, sulphur dioxide, sulphur trioxide and hydrogen sulphide from molecular and spectroscopic data. Values of the heats of formation of the various atomic and molecular species are selected from published experimental data, and certain industrially important equilibria are calculated. A.

536.7

3277. Thermodynamical study of the water-triethylamine system near its lower critical point. A. Bellemans. Letter in *J. chem. Phys.*, **21**, 368–9 (*Feb.*, 1953).

The L.C.P. for triethylamine : molecular fraction 0·15 is 18·4°C. The heat of mixing is measured at 16°C and the excess thermodynamic functions calculated. The conditions necessary for occurrence of a L.C.P. are discussed. C. TURNER

536.7 : 530.162

3278. The statistical aspect of Boltzmann's *H*-theorem. D. ter Haar and C. D. Green. *Proc. Phys. Soc.* [*London*] *A*, **66**, 153–9 (*Feb.*, 1953).

The statistical aspect of the second law of thermodynamics is illustrated by a discussion of two simple models. In both cases the most probable behaviour, and the mean life and the average time of recurrence of different states of fluctuation are obtained and discussed. A.

536.72

3279. A discussion of the first law of thermodynamics for open systems. H. A. Tolhoek and S. R. de Groot. *Physica*, **18**, 780–90 (*Oct.*, 1952).

A comparison is made of the extents to which the first law of thermodynamics is a physical law, or a definition, if it is generalized so as to be valid for open systems. The conclusion is reached that it is

partly a definition. Different generalizations of the first law, which can be proposed, must be considered as different definitions. The usefulness of these different definitions is compared with respect to the shift of arbitrary constants in the internal energy and in view of the thermodynamics of irreversible processes. A.

536.75 : 532.77

3280. The thermodynamic properties of saturated water. R. W. HAYWOOD. *Proc. Instn Mech. Engrs B*, **1**, *No.* 2, 49–63 (1952).

The general properties of the temperature-entropy diagram for water and steam are examined. By a simple device resulting from the use of Clapeyron's equation, it is shown that it is possible to give a very complete representation of the thermodynamic properties of saturated liquids by areas on this diagram. The second part constitutes a critical review of Callendar's hypothesis that saturated water contains in solution its own volume of saturated steam, and the pictorial representation of the properties of saturated water is here found to be very useful. In an appendix the use of Callendar's hypothesis as a working proposition is shown to give elegant and rapid evaluation of the relations required in the calorimetry of saturated water under ideal experimental conditions. The ability to use the hypothesis under these conditions does not, however, constitute a proof of its validity. The third part shows that the failure of Callendar's hypothesis to fit the experimental data can be accounted for by supposing that the quantity of dissolved steam is related to, but less than, that postulated by Callendar. This leads to an interesting picture which bears some resemblance to certain aspects of the hole theory of liquids. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.213 : 517.947.42

3281. On the calculation of the electrostatic capacity of a conductor. W. GROSS. Note in *R.C. Accad. Naz. Lincei*, **12**, 496–506 (*May*, 1952) *In Italian.*

An approximation to the surface charge density is obtained as a series of harmonic functions, the coefficients being determined by a variational method. Formulae are obtained for upper and lower bounds to the capacity, and illustrative calculations are made for a cube. R. A. NEWING

537.213 : 621.317.723 : 621.317.726

3282. An electrometer valve voltmeter of wide range. A. W. BREWER. *J. sci. Instrum.*, **30**, 91–2 (*March*, 1953).

An electrometer valve, combined with an ordinary pentode or triode valve, both acting as cathode followers, can provide a valve-voltmeter of very high input impedance, low input capacitance and of wide range. By using two further ordinary pentodes as "tail" valves the range can be extended to ±500 V without difficulty and with an input to output magnification of 0·99. The input grid current is not increased by the wide range, while the presence of a very closely following output facilitates guard ringing and the reduction of input leakages and capacitances. The arrangement will have several uses and has been especially designed for use for measurements of the atmospheric potential gradient using a radioactive collector, where it is more convenient and more rapid in response than most other methods. A.

537.213 : 621.317.726.088

3283. Non-linearity in a voltmeter using cathode-follower and thermocouple. D. G. TUCKER. *J. sci. Instrum.*, **30**, 11–13 (*Jan.*, 1953).

The problem analysed is that of the error due to valve non-linearity in an instrument comprising a galvanometer connected to a thermocouple, the heater of which is used as the cathode load of a cathode-follower; such an instrument enables measurements of a.c. voltages, whether sinusoidal or complex, to be made against a d.c. standard without appreciable loading of the source. One cause of error is evidently the effect of valve non-linearity, since the a.c. and d.c. inputs produce very different swings of grid voltage. The analysis shows, however, that this error is usually very small, and in a good design need not prevent a voltage of about 0·8 V being standardized to 0·1%. A.

537.221 : 541.183 : 621.317.321 : 621.319.43 : 621.314.58

3284. Theory of the vibrating condenser converter and application to contact potential measurement. J. R. ANDERSON AND A. E. ALEXANDER. *Austral. J. appl. Sci.*, **3**, 201–9 (*Sept.*, 1952).

An equation has been derived giving the nature of the a.c. signal generated by a vibrating condenser under various operating conditions. This shows that provided the impedance of the load is large compared with that of the vibrating condenser, the harmonic content of the generated signal is small even though the capacity change is relatively large. The magnitude of the generated signal decreases as the impedance of the load decreases. The application to the measurement of contact potentials is briefly discussed, and it is shown that, contrary to statements which have appeared in the past, inhomogeneity of a surface with respect to the work function does not hinder the measurement of contact potentials by this method. A.

537.224

3285. Effects of water vapour on the electrical properties of anodized aluminium. F. ANSBACHER AND A. C. JASON. Letter in *Nature* [*London*] **171**, 177–8 (*Jan.* 24, 1953).

The capacitance of a condenser formed by means of a 1 micron oxide layer on a $\frac{1}{16}$ in. dia. Al wire is found to vary systematically with temperature and vapour pressure. The effect may be of use in the measurement and control of humidity.

C. A. HOGARTH

537.226 : 548.5

3286. Report on researches with ferroelectric materials. H. F. KAY. *Rep. Brit. Elect. Res. Assoc.*, *Ref. L/T257*, 18 *pp.* (1951).

The chief aim of this work was the production of

ferroelectric crystals suitable for X-ray and optical crystallographic studies. It does not include the production of large crystals suitable for electrical investigations. A.

537.226 : 621.319

3287. Plastic electrets. H. H. Wieder and S. Kaufman. *J. appl. Phys.*, **24**, 156–61 (*Feb.*, 1953).

A brief discussion of proposed explanations for the electret effect is presented. Plexiglas, Lucite and Nylon electrets were prepared under fields ranging from 19 to 36 kV/cm and observed for as long as 2000 hours. The surface charge densities were measured by electrostatic induction using a commercial electronic electrometer and a shunt capacitance to reduce the readings to a maximum of 20 V. The initial state was a heterocharge or a homocharge depending on the strength of the forming field. The steady state was a homocharge in every case. Charge densities as high as $5{\cdot}5\times10^{-9}$ coulomb/cm² (16·5 e.s.u.) were observed. A Plexiglas disk was charged at room temperature under a strong field and its subsequent decaying homocharge recorded. The experimental results support the ideas of Mikola and Gross, i.e. the existence of two decaying polarizations of opposite sense due to ionic migration, one occurring within the dielectric, the other, across the electrode-dielectric interface. A.

537.226.2

3288. Some measurements on the dielectric polarization of alcohol mixtures. H. R. Sarna and P. N. Trehan. Letter in *Curr. Sci.*, **21**, 306–7 (*Nov.*, 1952).

The polarizations of *n*-butyl and *n*-amyl alcohol mixtures are almost linear with concentration.

D. H. WHIFFEN

537.226.2

3289. Some remarks on the paper "Dynamics of barium titanate polarization process." M. S. Kosman. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 2 (8) 239 (1952) *In Russian.*

A statement [Abstr. 989 (1952)] that the measurements by Kosman [Abstr. 2439 (1950)] of permittivity by discharge of a condenser through a ballistic galvanometer were faulty due to the conductivity of samples is disputed. Such conductivity could lead only to a low value of permittivity and so the high measured values above the Curie point cannot be due to experimental errors. The charging method using fully depolarized samples and a ballistic galvanometer is suitable where conductivity of samples does not influence results. It is alleged that, contrary to statements in the paper of Abstr. 989 (1952), applied wave-form was not rectangular, also time of impulses was longer than quoted, and should vary according to the charging potential.

J. LUKASZEWICZ

537.226.2

3290. On account of remarks of M. S. Kosman on "Dynamics of barium titanate polarization process." E. V. Sinyakov, E. A. Stafiĭchuk and B. K. Chern'yĭ. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 2 (8) 240 (1952) *In Russian.*

See preceding abstract. A decrease in values of permittivity would occur in the method of measurement by discharge through a ballistic galvanometer if only a through current existed in the usual range of temperatures. However, there is a predominant absorption current in barium titanate, and it falls sufficiently slowly to cause measurement errors. Details of the authors' own experiments [Abstr. 989 (1952)] show all Kosman's criticisms to be incorrect.

J. LUKASZEWICZ

537.226.2 : 538.569.3 : 621.392.26 : 621.315.61

3291. Wave-guide measurements in the microwave region on metal powders suspended in paraffin wax. J. M. Kelly, J. O. Stenoien and D. F. Isbell. *J. appl. Phys.*, **24**, 258–61 (*March*, 1953).

Artificial dielectrics have been constructed with indices of refraction as high as 7·2 at a frequency of 9364 Mc/s by imbedding microscopic conducting flakes in paraffin wax. When good conductors such as Cu and Al are used, the resulting permeability is observed to be complex while the permittivity is substantially real. This phenomenon is in agreement with the theoretical results of Lewin. It is indicated that a low loss, high refractive index artificial dielectric can be constructed by using powdered conductors if the particles are very small and possess a high electric polarizability. A.

537.226.3

3292. Dipole loss in polystyrene and derivatives. E. B. Baker, R. P. Auty and G. J. Ritenour. Letter in *J. chem. Phys.*, **21**, 159 (*Jan.*, 1953).

As described in Abstr. 1748 (1950), ε'' and ε' are determined as a function of $1/T$ for pure and cross-linked polystyrene and for polystyrene plasticized with diphenyl. In all cases a characteristic dipole loss peak above the 2nd-order transition point is found. This is attributed to the residual phenyl group dipole moment. The region below the transition shows a sharp decrease in slope, which is the same for all frequencies. This is due to a wider distribution of relaxation times. The loss peaks are asymmetrical: they can be explained by Davidson and Cole's relation [Abstr. 1763 (1952)]. A. J. TAYLOR

537.226.3

3293. Dielectric losses of sodium chloride crystals. Y. Haven. Letter in *J. chem. Phys.*, **21**, 171–2 (*Jan.*, 1953).

Contributions to the total losses $\tan\delta$, having a Debye type of frequency dependence, and attributable to associated pairs of lattice defects, are recognizable in measurements made on crystals containing Mn^{2+} or Ca^{2+} impurities when these are plotted as log $\tan\delta \sim$ log frequency. The peaks increase with impurity content. At 110°c each impurity gives a peak at about the same frequency. For Ca its position varies with temperature with an activation energy 0·7 eV.

A. D. LE CLAIRE

537.226.31 : 548

3294. Electrical conductivity of certain crystalline materials after grinding. J. S. Dryden and R. J. Meakins. Letter in *Nature* [*London*] **171**, 307–8 (*Feb.* 14, 1953).

Many inorganic salts and some crystalline organic compounds show a large increase in low frequency dielectric loss on grinding. It is suggested that the

effect is connected with the redistribution of adsorbed layers of water. C. A. HOGARTH

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3.08 : 621.317.715.082.742

3295. A moving coil galvanometer of extreme sensitivity. K. COPELAND, A. C. DOWNING AND A. V. HILL. *J. sci. Instrum.*, **30**, 40–4 (*Feb.*, 1953).

A sensitive moving coil galvanometer is described which is stable enough, under ordinary laboratory conditions, to allow a 20- to 50-fold magnification of its movements. The magnified deflection is read on a standard microammeter. Negative feedback from the output of a photoelectric amplifier to the galvanometer circuit allows the sensitivity to be diminished as required, with corresponding gain in stability. The galvanometer is strongly overdamped, but its short natural period gives it a reasonably short deflection time (a few seconds). Tests of performance show that the average error of a single deflection, in spite of the manifold disturbances of a busy laboratory, corresponds to about 0·002–0·004 μV. In a quiet place it would be considerably less. A.

537.3.08 : 530.162 : 621.317.715.082.742

3296. The Brownian fluctuations of a coupled galvanometer system. A. V. HILL. *J. sci. Instrum.*, **30**, 44–5 (*Feb.*, 1953).

When two galvanometers are coupled by a photocell and amplifier, the fluctuations of the primary one are reduced by the inertia and damping of the secondary one. The Brownian fluctuations of a single moving-coil galvanometer have a r.m.s. value $1{\cdot}12\times10^{-10}/(r_1\tau_1)^{\frac{1}{2}}$ A where r_1 is the total resistance for critical damping and τ_1 is the period. Recorded on a secondary galvanometer these fluctuations have a r.m.s. value $1{\cdot}12\times10^{-10}/(rt)^{\frac{1}{2}}$ A, where r is the actual circuit resistance of the primary galvanometer and t has a value which can be calculated. In a practical case considered $t \simeq$ the period of the secondary galvanometer. A.

537.311.32

3297. The electrical conductivity and the transformations of magnetite. M. BERNARD AND J. JAFFRAY. *J. Phys. Radium*, **13**, 705–15 (*Dec.*, 1952) *In French.*

The known experimental results on conductivity as a function of temperature are related to structural changes in Fe_3O_4 at various temperatures, such as a re-ordering of lattice positions. C. A. HOGARTH

537.311.33

3298. On new semiconducting compounds. H. WELKER. *Z. Naturforsch.*, **7a**, 744–9 (*Nov.*, 1952) *In German.*

Presents a discussion of the effect that compounds of elements of the third group of the periodic table (Al, Ga, In) with elements of the fifth group (P, As, Sb) have many similarities with elements of the fourth group (diamond, Si, Ge, grey Sn), These similarities include crystal structure, values of the lattice parameters, effective electron masses and electron mobilities, semiconducting and rectifying properties. Impurity atoms of the second group act as electron donors, atoms of the sixth group as acceptors, in these compounds, in analogy with the action of atoms of the third and fifth group respectively in the element semiconductors of the fourth group.

P. T. LANDSBERG

537.311.33

3299. Intrinsic conduction in PbS, PbSe, PbTe. E. H. PUTLEY. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 993 (*Dec.*, 1952).

Summarized results are presented for single crystals and the values of forbidden gap are calculated from Hall constant data. The values for conductivity measurements are smaller than those from Hall effect data, but the gap for PbSe is smaller than for PbTe.

C. A. HOGARTH

537.311.33

3300. The measurement of drift mobility in semiconductors. R. LAWRANCE AND A. F. GIBSON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 994–5 (*Dec.*, 1952).

Results of measurements on *n*-type Ge are reported. Modifications of the Haynes–Shockley method, using pulsed sweeping field/d.c. emitter and pulsed sweep field/light spot emitter, are described, and found to be advantageous in some experiments. The width of the arrival pulse at the collector is measured and used to check the value for the diffusion constant for holes in *n*-type Ge. C. A. HOGARTH

537.311.33

3301. Carrier injection and extraction in lead sulphide. P. C. BANBURY. *Proc. Phys. Soc.* [*London*] *B*, **66**, 50–3 (*Jan.*, 1953).

A method of measuring changes of minority carrier concentration in a semiconductor is discussed. The method is applied to the investigation of injection in specimens of *p*-type PbS which show transistor action. There is evidence of electron injection at both "point" metal contacts and contacts of area up to 10^{-4} cm². In the latter case an additional effect is observed which is interpreted as the reverse of injection, i.e. electron extraction. A.

537.311.33

3302. Electric resistivity of interstitial compounds of graphite. S. MROZOWSKI. *J. chem. Phys.*, **21**, 492–5 (*March*, 1953).

Assuming that the formation of interstitial compounds is accompanied by creation of excess holes in the otherwise full band of graphite, it is shown that a linear energy-momentum relation at the Brillouin zone corners is incapable of explaining the decrease of the electric resistance with oxidation. It appears that for a more general model the decrease in relative resistance should be independent of temperature for large oxidations if suitable corrections for the initial conditions are made. Data for polycrystalline graphite corrected for the existence of an energy gap and of excess holes in the untreated material give curves which converge for higher oxidation with the curve for natural graphite. Discussion of the low temperature properties of graphite leads to the conclusion that large graphite crystals possess slightly overlapping zones. A.

537.311.33 : 538.63

3303. Theory of the magnetoresistive effect in semiconductors. V. A. JOHNSON AND W. J. WHITESELL. *Phys. Rev.*, **89**, 941–7 (*March* 1, 1953).

Experiments show that the application of a magnetic field increases the resistivity of a semiconductor and produces a decrease in the magnitude of the Hall coefficient. Existing theoretical treatments predict much smaller effects than are actually observed in semiconductors. The present calculation has been carried out to see if theory is brought closer to experiment by considering (1) scattering of conduction electrons by impurity ions as well as by the lattice, and (2) conduction by both holes and electrons at high temperatures. The calculation shows that the presence of impurity scattering decreases the magnitude of the effects produced by a magnetic field and thus increases the gap between theoretical and experimental values. It is noted that the discrepancy decreases with falling temperatures and is no longer present for data measured on a Ge sample at 20°K. The calculated magnetic field effects are very much greater for an intrinsic semiconductor than for an impurity semiconductor. The fractional changes in resistivity and Hall coefficient are given, for several different values of the electron-hole mobility ratio, as functions of a parameter containing magnetic field strength and temperature. The absence of experimental values of the magnetic field effects at high temperatures prevents comparison of theory and experiment for the intrinsic semiconductor. A.

537.311.33 : 621.315.59

3304. Thermo and galvano-magnetic coefficients for semiconductors. E. H. PUTLEY. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 991–3 (*Dec.*, 1952).

It is shown why theoretical formulae based on classical statistics are applicable to the Nernst effect but not to the Ettingshausen and Righi–Leduc effects. The classical formulae must then be multiplied for the latter by the ratio of electronic to total thermal conductivity. The calculations are illustrated by results for Ge and PbSe. C. A. HOGARTH (R)

537.311.33

3305. The electrolytic aluminium-oxide rectifier. S. SHINOHARA AND R. HOSHINO. *J. Fac. Sci. Hokkaidô Univ. II*, **4**, 140–6 (*March*, 1952).

The rectifying property is due to a double layer between negative ions, adsorbed on an oxide film in electrolytic solution, and positive charges induced in the metal by them. A relation of electric resistance to applied voltage is obtained, and it is shown that current carriers in Al_2O_3 are Al^+ ions and the film of Al_2O_3 is about 10^{-5} cm in thickness. A.

537.311.33

3306. On impurity and intrinsic semiconduction of intermetallic compounds. II. E. JUSTI AND G. LAUTZ. *Z. Naturforsch.*, **7a**, 602–13 (*Sept.*, 1952).

For Pt I, see Abstr. 5111 (1952). Experimental results on the alloy CdSb are reported, and include the temperature dependence of the electrical resistance, rectifying properties and various second-order effects (Hall coefficient, etc.). It is inferred that the substance behaves like a deficit semiconductor with three activation energies and a gap width of 0·522 eV. The temperature dependence of the mobility was found not to obey the $T^{-3/2}$ law. P. T. LANDSBERG

537.311.33

3307. Height of the potential barrier in barrier layer cells. M. S. RIDOUT. Letter in *Nature* [*London*] **171**, 219 (*Jan.* 31, 1953).

A statistical analysis of the distribution of a quantity ϕ, which on simple theory might be expected to be the barrier height, shows how a mean value $\overline{\phi}$ and S the standard deviation may be computed from rectification curves using the zero resistance. The value $\overline{\phi}$ is certainly not the barrier height (since it may be considerably higher than the forbidden band width), but the results for $\overline{\phi}$ and S indicate the degree of uniformity of the layer, and the general results agree with the multi-contact theory.

C. A. HOGARTH

537.311.33

3308. Resistance of germanium contacts. J. B. GUNN. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 908–9 (*Nov.*, 1952).

Derives an approximate theory to explain the current-voltage characteristics at high voltages, of rectifying point contacts and relates the theory to some experimental results. W. BARDSLEY

537.311.33

3309. Properties of thermally treated germanium. L. ESAKI. *Phys. Rev.*, **89**, 1026–34 (*March* 1, 1953).

Upon heating a piece of Ge in a vacuum of 10^{-6} mm Hg, the following results have been obtained. (1) Below 350°C, the rectification characteristic is improved. Heating the specimen at a temperature between 400°C and 600°C destroys the rectification, which is not recovered completely when it is heated in vacuum. However, heating in an O atmosphere leads to a slight recovery of the rectification. (2) Treatment above 550°C makes the formation of acceptor levels detectable. With continued heating at 500°C for about 48 hours, the specimen returns again to *n* type similar to the original state. The formation and disappearance of acceptor levels were followed when the specimen was quenched from a fixed temperature to room temperature. The equilibrium concentration at the heating temperature was determined to be $A = 2{\cdot}5\times10^{21}\exp(-27\,000/RT)\ \mathrm{cm}^{-3}$. (3) On the assumption that the acceptor levels produced on the surface diffuse into the interior, the data could be fairly well represented with an estimated diffusion coefficient: $D = 300\exp(-37\,000/RT)\ \mathrm{cm}^2\ \mathrm{sec.}^{-1}$. (4) The resistivity and Hall coefficient from room temperature to about 200°C have been measured for several specimens. A.

537.311.33 : 669.783 : 621.314.63

3310. A thermoelectric study of the electrical forming of germanium rectifiers. M. KIKUCHI AND T. ONISHI. *J. appl. Phys.*, **24**, 162–6 (*Feb.*, 1953).

The electrical forming phenomena on the etched surfaces of *n*-type Ge crystals by a.c. voltages were studied thermoelectrically. Remarkable improvements in the current/voltage characteristics were obtained by applying appropriate forming voltages. The thermo-electric current observed on the etched surface showed *n*-type direction but it was converted to *p*-type by the forming. It has also been found out

that the thermo-e.m.f. depends sensitively on the pressure of the whisker contact after the forming (and on the polished surface), while the dependence is small before the forming on the etched surface. Experimental results seem to show that some substance of relatively high resistivity and of *p*-type thermo-e.m.f. is produced by the forming between the whisker metal and the Ge surface. A.

537.312.5

3311. Perturbations on exciton states in molecular crystals. H. WINSTON. Letter in *J. chem. Phys.*, **21,** 170–1 (*Jan.*, 1953).

Slater's method of treatment [Abstr. 3157 (1950)] of single particles in a perturbed periodic potential is adapted to this problem. A. D. LE CLAIRE

537.312.5

3312. Long wavelength infra-red photoconductivity of silicon at low temperatures. B. V. ROLLIN AND E. L. SIMMONS. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65,** 995–6 (*Dec.*, 1952).

Measurements at liquid hydrogen temperatures on *p*-type Si with 10^{16}–10^{17} free carriers per cm^3 and an activation energy of 0·05 eV are reported. This value suggests a photoconductive effect to 25 μ and results show this to the measurement limit, 14 μ. The fast response $<2\times10^{-4}$ sec at 10 μ indicates a true photoconductive effect. At 10 μ under optimum conditions 10^{-8} watt/cm^2 could be detected.

C. A. HOGARTH

537.312.5

3313. Long wavelength infra red photoconductivity of silicon at low temperatures. B. V. ROLLIN AND E. L. SIMMONS. *Proc. Phys. Soc.* [*London*] *B*, **66,** 162–8 (*March*, 1953).

The conductivity of silicon at low temperatures is found to be increased by illumination with i.r. radiation in the wavelength range 2 to 14 μ. The effect is believed to be due to excitation of electrons or holes from impurity states. At 14°K, for radiation of wavelength 10 μ, interrupted at 800 c/s, a signal equal to noise in a bandwidth of 1 c/s is obtained with an incident intensity of about 2×10^{-8} watt/cm^2 on a specimen of area 0·1 cm^2. A.

537.312.62

3314. On the phenomenological theory of superconductivity. (Remarks on a paper of the same title by H. Koppe.) F. BECK. Note in *Z. Naturforsch.*, 7a, 820–1 (*Dec.*, 1952) *In German.*

See Abstr. 9489 (1951). Attention is drawn to an error and a new relation between the superconductivity constant Λ and the current density is derived.

H. LONDON

537.312.62

3315. Some properties of superconductors below 1°K. T. S. SMITH, W. B. GAGER AND J. G. DAUNT. Letter in *Phys. Rev.*, **89,** 654 (*Feb.* 1, 1953).

A Ti sample purer than in Abstr. 864 (1953) gives the lower transition temperature $T_c = 0{\cdot}387$°K and a slope of the magnetic threshold curve at T_c of 89·5 gauss/deg (temperature in Curie scale for CrK-alum). The resulting thermodynamically calculated electronic heat $C_{el,n} = 1{\cdot}1\times10^{-4}T$ cal/mol degree is considerably smaller than that measured directly in the liquid He region [Abstr. 8144 (1952)].

H. LONDON

537.312.62

3316. Superconducting silicides and germanides. G. F. HARDY AND J. K. HULM. Letter in *Phys. Rev.*, **89,** 884 (*Feb.* 15, 1953).

The following compounds became superconducting at the temperatures (in °K) indicated: V_3Si (17·0), V_3Ge (6·0), Mo_3Si (1·3), Mo_3Ge (1·43), $MoSi_{0.7}$ (1·34), $MoGe_{0.7}$ (1·2), $WSi_{0.7}$ (2·84), $ThSi_2$ (3·16). The following were not superconducting at 1·2°K: Ti_5Si_3, Ti_5Ge_3, TiSi, $TiSi_2$, $TiGe_2$, Zr_4Si, Zr_2Si, Zr_3Si_2, Zr_4Si_3, Zr_6Si_5, ZrSi, $ZrSi_2$, VSi_2, $NbSi_{0.6}$, $NbSi_2$, $TaSi_2$, Cr_3Si, Cr_3Si_2, CrSi, $CrSi_2$, WSi_2, $MoSi_2$. The transition temperature of V_3Si is the highest yet found for any substance; it was found to be depressed if 0·1 of the V was replaced by Ti, Zr, Nb, Mo, Cr or Ru or if 0·1 of the Si was replaced by B, C, Al or Ge.

D. SHOENBERG

537.312.62 : 536.21

3317. The thermal conductivity of superconducting tin below 1°K. B. B. GOODMAN. *Proc. Phys. Soc.* [*London*] *A*, **66,** 217–22 (*March*, 1953).

An account is given of measurements on the thermal conductivity of superconducting tin below 1°K, made by observing the conduction of heat along a tin rod joining two pills of paramagnetic salt. Measurements were made on specimens of widely differing purities and a comparison of the results for the several specimens enabled an estimate to be made of the separate contributions, from the electrons and from the lattice, to the conductivity of each specimen. The electronic contribution to the thermal conductivity is in agreement with calculations due to Heisenberg and Koppe. The significance of this is discussed and it is tentatively suggested that the thermodynamic properties of the superconducting state may be determined by an energy gap of order kT_c in the spectrum of energy levels available to the electrons.

A.

537.312.8

3318. Influence of a magnetic field on the electrical resistance of iron films. B. FRANKEN, A. VAN ITTERBEEK, G. J. VAN DEN BERG AND D. A. LOCKHORST. *Physica*, **18,** 771–9 (*Oct.*, 1952).

It is supposed that the coercive force of an Fe film can be evaluated by the value of the field at an extreme in the curve of the change of the electrical resistance as a function of the magnetic field. For the bulk material this supposition is approximately right at room temperature and this was tested at low temperatures. The coercive force is measured as a function of temperature down to liquid He temperatures. The results are discussed in relation to the theory as considered by Kittel in 1949. A.

537.312.8 : 536.48

3319. Change of resistance of metals in a magnetic field at low temperature. E. S. BOROVIK. *Zh. eksper. teor. Fiz.*, **23,** *No.* 1 (7) 91–100 (1952) *In Russian.*

The magneto-resistance effect was studied in transverse fields of up to 20 000 gauss in a Sn and an In crystal at liquid He and H temperatures. For Sn

the increase of resistance was strongly anisotropic, $\Delta r/r$ at 4·2°K varying from about 8 for the tetrad axis parallel to the field to 150 perpendicular, for 20 000 gauss; the variation is not monotonic, showing pronounced dips when the field is at 24° and 40° to the tetrad axis. The curve of $\Delta r/r$ against H for the field parallel to the tetrad axis shows a pronounced dip at 4000 gauss, and other slight irregularities (not correlated directly with the de Haas–van Alphen effect oscillations). For In, $\Delta r/r$ is much smaller ($\sim$1 at 20 000 gauss and 4·2°K) and shows much less anisotropy. These results and those of other authors on other metals are discussed in relation to current theory. D. SHOENBERG

537.32 : 537.534.9

3320. Induced thermoelectric potential from radiation damage. A. ANDREW AND C. R. DAVIDSON. Letter in *Phys. Rev.*, **89**, 876 (*Feb.* 15, 1953).

It is shown that bombardment of 0·005 in. iron and constantan wires by 10 MeV protons increases the thermo-e.m.f.'s considerably. Annealing the specimens at successively higher temperatures restores the original values. C. A. HOGARTH

537.36

3321. An electromagnetokinetic phenomenon involving migration of neutral particles. A. KOLIN. *Science*, **117**, 134–7 (*Feb.* 6, 1953).

When an enclosed conductive fluid is traversed by a current, a perpendicular magnetic field produces a force (perpendicular to both directions) on the moving charges; and this is balanced by a pressure gradient in the liquid. An immersed body, of different conductivity, is acted on by a resultant force; for example, an air bubble will not rise in acidulated water placed in a horizontal magnetic field of 10 000 oersteds traversed by a perpendicular horizontal current of 1 amp/cm². Approximate expressions for such forces are derived, and found to be in good agreement with experiment. Practical applications of the effect are suggested. P. M. DAVIDSON

537.36 : 534.39

The acousto-electric effect. *See Abstr.* 3066

537.36 : 535.371.01

Streaming potential measurements and the adhesion of phosphors on cathode ray screens. *See Abstr.* 3162

537.363

3322. Moving-boundary electrophoresis of colloidal electrolytes using concentration boundaries. H. LAL. Letter in *Nature* [*London*] **171**, 175–6 (*Jan.* 24, 1953).

Describes preliminary results obtained with the "open" electrode system for potassium laurate and lauryl sulphonic acid solutions at 0·5°C. When both potassium laurate solutions were kept below the critical concentration for micelle formation, the boundaries in the two limbs of the Tiselius cell moved towards each other regardless of the direction of the current. When the dilute solution had a concentration of $c'' = 0{\cdot}25\%$ while the concentrated solution had a concentration c' varying from 0·7 to 2·00%, the anion transference number increment showed a sharp rise when c' exceeded the critical concentration for micelle formation. Finally, when c' was fixed at 2·0%, while c'' varied from 0·25 to 1·50%, the boundaries moved in the opposite direction to the positive current. The critical concentration for micelle formation was determined as 0·83% for potassium laurate, and 0·25% for lauryl sulphonic acid. F. LACHMAN

537.363

3323. Photoelectric control of the compensator in electrophoresis. R. L. WARREN AND P. A. CHARLWOOD. Letter in *Nature* [*London*] **171**, 353–4 (*Feb.* 21, 1953).

Very little light reaches the camera screen of the Tiselius electrophoresis apparatus and a very sensitive photocell is required to actuate a controller. A Schwartz photoconductive cell receives the light and its output operates a spot galvanometer. A second photocell in the plane of the galvanometer scale operates a relay, supplying current to the compensator. Practical details are given. R. W. FISH

ELECTRIC DISCHARGES 537.52

537.521 : 538.12 : 521.038

3324. Origin of magnetic fields in moving plasma. L. BIERMANN. *Ann. Phys. Leipzig*, **10**, *No.* 8, 413–17 (1952) *In German.*

Connection between the modes of vibration of a plasma. A. SCHLÜTER. *Ibid.*, 418–21. *In German.*

Plasma in a magnetic field. A. SCHLÜTER. *Ibid.*, 422–9. *In German.*

A mathematical treatment of the problem of interaction of ionized matter (ions + electrons) in magnetic fields. The first paper deals with the origin and maintenance of the magnetic field in stellar and interstellar matter in motion. The second and third papers discuss hydrodynamic motions of plasma particles under the influence of an applied field. D. R. BARBER

537.523/.525

3325. The formation of strata in electrical discharge in gas. B. N. KLYARFEL'D. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 66–7 (1952) *In Russian.*

The author's experiments on the stratifications in the electrical discharges in gases yielded the following results: (1) The stratification can be originated by a local steep rise of the potential or of the concentration of ions or electrons independently of the cause of such rise. The strata are always situated on the anode side. In some cases the degree of the stratification is not altered with the distance from the point of its origin ("continuous" stratification); in some other cases it is reduced with this distance ("damped" stratification). (2) The formation of each stratum is determined by a process which takes place on its cathode side. (3) In the majority of cases the strata are moving; in some instances this motion can be controlled to a considerable degree by applying superimposed local fields by means of probes. The motion of the strata can be detected by means of rotating mirrors. (4) In the vast majority of cases it is the positive column which is stratified. The

stratification was clear at large current densities (up to 300 amp/cm²) in capillary tubes of 0·1 mm dia. and at a very large range of pressures (up to and above the atmospheric pressure). The discharge column is continuous at very low pressures and also in metal vapours of Na, Cs, Cd and Hg, and in the noble gases with a small admixture of H_2. (6) The pressure of negative ions is not a necessary condition for stratification. The experiments are described in some detail with illustrations by photographic records of stratifications. These experimental results are explained on the basis of the usual theory of discharge currents, as the resultants of the action of the electric forces in the proper sense and of the forces of diffusion depending on the concentrations of particles.

N. S. JAPOLSKY

537.523.3 : 621.3.015.532

3326. On the theory of the corona discharge under constant potential. L. É. Tsȳrlin. *Zh. tekh. Fiz.*, **22**, *No.* 7, 1184–9 (1952) *In Russian.*

Theoretical consideration of the corona discharge between an infinitely long cylindrical conductor and a plane parallel to it under constant potential. The solutions of the problem of the volt/ampere function, distribution of the field and the current and discharge are evolved on the assumption that the geometrical configuration of the static field is maintained.

Z. F. WOJNAR (R)

537.523.3 : 537.563

3327. Ions formed in a room by negative wire corona. H. Norinder and R. Siksna. *Ark. Fys.*, **6**, *Paper* 14, 127–40 (1952).

Using Ebert and Israel ion counters, the free ionization caused in a room by corona has been measured. Details of the corona electrode assembly and power supply are given. The densities of ions were measured as a function of time for various discharge potentials, etc., and varied from maxima of ~50 000 ions/cm³. Appreciable ionization persisted for ~2 hr after removal of the discharge voltage. The results are presented graphically in considerable detail.

J. D. CRAGGS

537.523.4

3328. Mechanism of long-gap negative spark discharges in air at atmospheric pressure. H. Norinder and O. Salka. *Ark. Fys.*, **5**, *Paper* 24, 493–529 (1952).

Describes expts. made with sphere-plate or point-plate electrode arrangements, using gap lengths varying up to 120 cm. Impulse waves (1/50 μsec waveshape) were used and the discharges could be chopped with a parallel discharge gap. The discharges were investigated mainly by photographic methods and the sequence of discharge forms is illustrated by 78 photographs. The latter are discussed, but no simple explanation of the pre-breakdown discharges is given. The discharges are very complicated in their later stages, i.e. near spark breakdown.

J. D. CRAGGS

537.525

3329. On the passage of a charged particle through an electron plasma. A. I. Akhiezer and A. G. Sitenko. *Zh. eksper. teor. Fiz.*, **23**, *No.* 2(8), 161–8 (1952) *In Russian.*

The kinetic theory of the interaction of a moving charged particle with the electron plasma is analysed. This study is essential for the explanation of the mechanism of the excitation of high-frequency vibrations of the plasma by the charged particles which pass through it. It was previously thought, on the basis of a hydrodynamic analysis of the problem, that the interaction of a particle with the plasma occurs only in the case when the velocity of the particle exceeds the average thermal velocity of the electrons of the plasma. It is shown here that in reality interaction occurs at all velocities.

E. RABKIN

537.525

3330. High frequency discharges in gases. G. D. Morgan. *Sci. Progr.*, **41**, 22–41 (*Jan.*, 1953).

Reviews mechanism of breakdown and maintenance of h.f. discharges in gases involving ionization by single electron impact and loss by diffusion, drift, attachment and recombination. H.F. discharges are generally simpler than static field discharges, owing to absence of electrode effects, but the positive columns or plasma are the same. The electron energy distribution function is unchanged when x/p and f/p are kept constant in similar discharges. Application of h.f. discharges to measure recombination and ambi-polar diffusion coefficients, to spectroscopy, particle detection and design of ion sources is indicated.

F. LLEWELLYN JONES

537.525.3

3331. Photoionization as an important secondary process in a low frequency electrodeless discharge. A. P. Saxena, M. G. Bhatawdekar and N. A. Ramaiah. Letter in *J. chem. Phys.*, **21**, 365 (*Feb.*, 1953).

The suggestion is made that certain current pulses in l.f. a.c. (~50 c/s) discharges are initiated by photoionization processes.

J. D. CRAGGS

537.525.5

3332. The velocity of cathode [vapour] streams in low pressure mercury arcs. H. Nöske and E. Schmidt. *Z. Naturforsch.*, **7a**, 677–82 (*Oct.*, 1952) *In German.*

By the use of a system of three probes, placed at increasing distances along the axis of the discharge tube, the velocity of propagation of the vapour stream from the cathode can be measured, using an oscillographic technique. The results give speeds ~10^5 cm/sec; detailed data, with a discussion, are given in the paper.

J. D. CRAGGS

537.525.5

3333. A ball of fire discharge with a pronounced current saturation. G. L. Medicus. Letter in *J. appl. Phys.*, **24**, 233–4 (*Feb.*, 1953).

Experiments were made with a diode (hollow oxide cathode) containing Xe at a pressure of 250 μ. It was found that a localized "ball of fire" was formed near the cathode opening and that the current-voltage characteristic showed a marked saturation. This is explained by the presence, as proved with a probe, of a strong negative space charge near the cathode opening.

J. D. CRAGGS

537.525.8

3334. On chemical reactions caused by electron excitation in the positive columns of glow discharges (toluol, benzol and ammonia). H. SCHÜLER AND V. DEGENHART. *Z. Naturforsch.*, **7a**, 753–6 (*Nov.*, 1952) *In German.*

Makes further reference to the new spectra found by Schüler and his collaborators with low pressure glows in certain complex molecular gases. The present paper deals with the chemical identification of the products of dissociation processes in such discharges, for the molecules named. J. D. CRAGGS

537.525.8

3335. On the plasma in rarefied gas at a variable current. V. L. GRANOVSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 3–10 (1952) *In Russian.*

General equations for comparatively slow non-stationary processes in the plasma at a regime of an "ambipolar" diffusion, which were previously evolved by a number of investigators, are now applied by the author to the calculation of the electron and ion concentration at a variable current passing through the plasma. Special consideration is given to the question of the partial de-ionization of the gas at a falling current and to the residual ion concentration after the complete interruption of the current. Two particular cases are discussed in some detail: (*a*) alternating sinusoidal current and (*b*) linearly falling d.c. N. S. JAPOLSKY

537.525.8

3336. Investigations in the field of gas discharge physics. R. SEELIGER. *Z. Naturforsch.*, **8a**, 74–9 (*Jan.*, 1953) *In German.*

A general summarizing article, dealing with the following aspects of l.p. glow discharges: (*a*) certain characteristics of positive columns in oxygen, the thickness of the cathode dark space in mixed gases (He–A, He–Hg, He–Cl_2, A–Cl_2, Xe–Cl_2) where A–Cl_2 and Xe–Cl_2 exhibit results of special interest, (*b*) certain features of probe behaviour, especially in electro-negative gases and finally (*c*) diffusion and recombination processes in plasmas. J. D. CRAGGS

537.525.8

3337. The energy spectrum, measured with high resolution, of cathode rays in gaseous discharges. G. MÖLLENSTEDT AND H. DÜKER. *Z. Naturforsch.*, **8a**, 79–90 (*Jan.*, 1953) *In German.*

A detailed study of the energy spectrum of electrons from l.p., high voltage (~40 kV) discharges. Magnetic and electrostatic systems were used to determine the beam energy spread (~ a few eV half-width) found for an electron beam passing from the discharge space into a separate high vacuum region, and these, with the results, are discussed in detail. J. D. CRAGGS

537.525.8 : 537.525.4

3338. The excitation of a hollow cathode discharge tube with impulses: production of spark lines. J. ROIG AND M. BÉCART. *C.R. Acad. Sci.* [*Paris*] **235**, 1625–7 (*Dec.* 12, 1952) *In French.*

Using pressures ~1 mm Hg, spark lines were obtained in He, air and A. The circuit is briefly described and its important parameters mentioned. Some argon spectra are reproduced. J. D. CRAGGS

537.525.8 : 537.525.5 : 621.327.43

3339. Low pressure mercury discharges. III. G. MEISTER AND T. H. HEINE. *Illum. Engng*, **47**, 660–6 (*Dec.*, 1952).

A continuation of previous work [Abstr. 5811 (1952)] using Xe–A and Xe–Ne mixtures. The variation of u.v. and fluorescent efficiency for mixtures of different proportions and at different pressures in the presence of Hg vapour at low pressure was studied, the maximum being obtained at 2 mm gas pressure for a 50 : 50 mixture of Xe and A and at 1mm pressure for a 75 : 25 mixture of Xe with Ne. The voltage of the discharge is lowest at 2 mm gas pressure for both mixtures. J. W. T. WALSH (R)

537.527.5

3340. The energy balance equation for the positive columns of high pressure arcs. K. S. W. CHAMPION. *Proc. Phys. Soc.* [*London*] *B*, **66**, 169–74 (*March*, 1953).

Expressions for the energy balance equation put forward by various authors are reviewed and the need for a more rigorous statement of this equation is pointed out. An equation is deduced which includes rigorous expressions for the conduction and convection losses and an approximate expression for the radiation loss. Another equation which must be solved simultaneously is the hydrodynamical equation of steady flow, which yields the gas drift velocity involved in the convection losses. These general equations, unfortunately, can only be solved for certain special sets of conditions. A solution is given for a special case of a cylindrically symmetrical vertical arc and it is found that on insertion of appropriate numerical values the calculated quantities are in good agreement with experiment. A.

537.528 : 621.3.015.5 : 621.315.615

3341. Electrical conduction and breakdown in liquid dielectrics. D. W. GOODWIN AND K. A. MACFADYEN. *Proc. Phys. Soc.* [*London*] *B*, **66**, 85–96 (*Feb.*, 1953).

Measurements of the breakdown strength of purified organic liquids have been made using rectangular voltage pulses of duration between 0·2 and 20 μsec. The effects of cathode metal, γ-radiation and of changes in pulse duration, electrode separation, temperature, constitution of the liquid, etc., lead to a theory of breakdown according to which an instability arises as a result of electron emission from the cathode and field distortion due to the movement of ions between the electrodes. Conduction measurements support the view that strong fields produce conduction by field emission from the cathode, together with ionization of the liquid molecules by electron collisions. This theory of breakdown accounts for the dependence of breakdown strength on electrode separation, cathode metal and pulse duration. It also suggests the relationship between breakdown strength and the temperature and constitution of the liquid. A.

537.529

3342. Variation of the electric strength of KCl and NaCl crystals with temperature. J. H. CALDERWOOD AND R. COOPER. *Proc. Phys. Soc.* [*London*] *B*, **66**, 74–80 (*Feb.*, 1953).

Describes measurements of the electric strength of crystals of KCl and NaCl which were made using both d.c. and standard $\frac{1}{50}$ μsec unidirectional impulse

voltages at temperatures between −74°C and +140°C. In this range of temperature, which included for both KCl and NaCl a transition from a region in which the electric strength increased with rise in temperature to one in which it decreased, no significant difference was found between values of electric strength obtained using d.c. and corresponding values obtained with impulses. This result contrasts with that of Suita for KCl. It supports qualitatively Fröhlich's theory of breakdown. A.

X-RAYS 537.531

537.531 : 535.338.334

3343. Contribution to the study of the widths of X-ray spectral lines. B. G. Gokhale. *Ann. Phys.* [*Paris*] **7**, 852–902 (*Nov.–Dec.*, 1952) *In French.*

The theory of factors influencing line width is considered, and the standard spectroscopic methods are reviewed. For the present experiments a bent mica crystal transmission spectrometer was used; the instrumental broadening in this is considered in detail. Measurements of the widths of $K\alpha$ lines of elements 37 Rb to 50 Sn were obtained (some for the first time) and are compared with other workers' results. The widths expressed in electron-volts are found to vary as Z^3. The bent-crystal spectrometer is found to be better than the double crystal spectrometer for this purpose. A. R. STOKES

537.531 : 535.43 : 532.7

On the theory of fluids. *See Abstr.* 3004

537.531 : 621.386.1–181.4

3344. An experimental X-ray apparatus with midget X-ray tube. P. J. M. Botden, B. Combée and J. Houtman. *Philips tech. Rev.*, **14**, 165–74 (*Dec.*, 1952).

The experimental X-ray tube described is 45 mm long and 14 mm in diameter, including the earthed metal jacket. The X-rays are excited in a very thin Au layer, deposited on a Be plate, which at the same time serves as exit window for the rays. The tube can be loaded with a voltage of 25 kV and a maximum power of 2·5 W. The half-value thickness of the radiation is very small, 0·5 mm tissue at 25 kV and 0·3 mm tissue at 10 kV, owing to the small "inherent filter" of the tube (equivalent to 1·5 mm Be). Very high dosage rates of some hundreds of thousands of röntgen units per minute can be obtained, in spite of the very small power, and a rapid decrease of the dose in proportion to depth, owing to the fact that the focus can be brought within 1 mm distance of the area to be irradiated. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 537.52

3345. Field emission of electrons in discharges. F. Llewellyn Jones and E. T. de la Perrelle. *Proc. Roy. Soc. A*, **216**, 267–79 (*Jan.* 22, 1953).

Substantial emission of 10^4 to 10^5 electrons/sec was obtained from cathodes of oxidized Ni and W with electric fields of about 10^5 V/cm. By relating this emission to the electric field by the Fowler–Nordheim equation, estimates of the work function and emitting area of the source of the electrons were made. It was found that the effective work function for the emitting source on oxidized Ni and W was roughly 0·5 eV, and that the emitting areas were 10^{-13} cm². This is consistent with the view that the electrons were obtained from the oxide itself and not from the underlying metal. The presence of tarnish films and oxides on electrodes enhanced the cold electron emission greatly, and played an important part in the mechanism of electron production; the presence of metallic dust was found to enhance the emission by factors up to 10^3. The technique used in the investigation provides a method by which a rapid assessment of the electron emissive properties of metals can be made, and is applicable to a wide variety of surfaces. A.

537.533 : 621.384.611

3346. Phase stability of the microtron. C. Henderson, F. F. Heymann and R. E. Jennings. *Proc. Phys. Soc.* [*London*] *B*, **66**, 41–9 (*Jan.*, 1953).

The limits of phase energy within which electrons can be stably accelerated in a microtron, or electron cyclotron, are calculated for a number of voltages by two different methods. The effect of small changes in the magnetic field are considered and the energy and phase of electrons after the first transit are given for different resonator gaps and voltages. The design of resonator and the operating conditions likely to give maximum output from this type of machine are discussed. A.

537.533.72

3347. Foundations of electron optics. [Grundlagen der Elektronenoptik.] W. Glaser. *Vienna: Springer-Verlag* (1952) 699 *pp. In German.*

A very complete and profound treatment of electron-optical theory. There are three parts: (1) lens fields and Gaussian dioptics; (2) the theory of geometrical aberrations; (3) electron optics and wave mechanics. The first part is mostly standard material, but given in an unusually complete and rigorous form. The second part deals with caustic surfaces, problems of electron intensity and the theory of deflection as well as with the ordinary third-order aberrations of the image. In the last part, the wave mechanical aspects of electron optics are developed sufficiently to discuss the resolving power of electron devices. The book includes 445 figures and extensive bibliographies. It does not deal with experimental questions, except those concerned with measurements of fields in lenses, nor with electron optical instruments in any detail. Neither are problems encountered with high current beams discussed. A. H. W. BECK

537.533.72

3348. Experimental study of the electrostatic immersion objective with plane electrodes: focusing curves and focal distance. A. Septier. *C.R. Acad. Sci.* [*Paris*] **235**, 1621–3 (*Dec.* 22, 1952) *In French.*

Describes the results of some experiments on the dependence of focusing curves and focal distance on anode radius and radius and thickness of the Wehnelt.

G. D. SIMS

537.533.72

3349. An experimental study of the electrostatic immersion objective with plane electrodes: extracting field E_0 under focusing conditions; geometrical aberrations outside the axis. A. SEPTIER. *C.R. Acad. Sci.* [*Paris*] **236**, 58–60 (*Jan.* 5, 1953) *In French.*

See also preceding abstract. Describes a lens determined from experiments in the electrolytic trough, which possesses the maximum resolving power over the largest possible region.

A. H. W. BECK

537.533.72 : 621.385.833

3350. Electrostatic lenses for focusing particles of very high energy. Field distribution. M.-Y. BERNARD. *C.R. Acad. Sci.* [*Paris*] **236**, 185–7 (*Jan.* 12, 1953) *In French.*

Describes theoretical work on lenses which are the electrostatic analogue of the magnetic lenses recently described by Courant, Livingston and Snyder [Abstr. 907 (1953)]. This note derives expression for the field in one unit and in a lens made up from two units separated by earthed screens. A. H. W. BECK

537.533.72 : 539.27

3351. Summarized proceedings of a conference on electron microscopy—Bristol, September 1952. V. E. COSSLETT, J. NUTTING AND R. REED. *Brit. J. appl. Phys.*, **4**, 1–5 (*Jan.*, 1953).

The autumn conference of the Electron Microscopy Group of The Institute of Physics. The papers presented and the discussion on them are summarized; they were concerned with chemical, biological and metallurgical applications of the electron microscope, the examination of surface structures by reflection electron microscopy, instrumental techniques and instrument design. A.

537.533.72

3352. Long magnetic lens beta-ray spectrometers. S. JNANANANDA. *J. sci. industr. Res.*, **11B**, 397–407 (*Oct.*, 1952).

I. Theory (397–400).

The motions of electrons in axially symmetric magnetic fields are dealt with and new expressions for obtaining the "determinants" of the traces of trajectories of electrons in an axially symmetrical field, for any value of α, are derived. A.

II. Design and construction (401–7).

The application of these expressions for designing long-lens β-ray spectrometers, their design features and constructional details, and the performance of some specific designs are described. The use of shaped "aberration-free" magnetic fields for improving the performance of the instrument is discussed. A.

537.533.72

3353. Development of a new method for the absolute determination of β-ray energies. H. CRAIG AND C. F. DIETRICH. *Proc. Phys. Soc.* [*London*] *B*, **66**, 201–15 (*March*, 1953).

Describes the use of a magnetic electron lens working at unit magnification, in which the image-rotating property is used to produce two line images by reversal of the current through the lens windings. It is shown how the specific momentum ($H\rho$) of the focused electrons may be found from a knowledge of the angle between the two lines, the mean current and the number of turns on the lens. This is followed by a theoretical investigation of the optimum conditions necessary to obtain the highest accuracy. A pilot experiment in which the formula for ($H\rho$) is tested, gave an accuracy within 1 in 700 for the ThF line. Further experimental work was carried out on a second lens to test the optimum conditions referred to above. It was shown that the angle between the lines could be determined to an accuracy within 1 in 30 000. It is further explained how, by the use of a new optical device, and on the basis of 25 readings, the angle between the lines could be established to an accuracy within 1 in 10^5. The second lens of which the number of turns is not known was used to investigate the specific momentum of the I, F and A lines of Th(B + C). In this application of the method the lens was calibrated by means of the I and F lines of ThB, giving the ratio of the two specific momenta, whilst the difference was obtained from X-ray data. An absolute determination of the A line is described. A.

537.533.73 : 535.41

3354. The crossing of two extinction lines in electron interference with convergent beams. C. MENZEL-KOPP. *Z. Naturforsch.*, **8a**, 28–30 (*Jan.*, 1953) *In German.*

Experimental examples of the behaviour of two extinction lines at their intersection are illustrated and a rule for the sense of the turning at the intersection is given, based on the studies of Fues (1939).

A. H. W. BECK

537.533.73 : 535.41

3355. Interference fringes obtained by the superposition of two coherent electron beams. R. BERNARD AND E. PERNOUX. *C.R. Acad. Sci.* [*Paris*] **236**, 187–9 (*Jan.* 12, 1953) *In French.*

A new interference phenomenon, observed when two thin crystals are superposed in the electron microscope, is described. Equidistant bands alternately dark and light are observed and the phenomenon is reproducible with lead iodide or molybdic oxide. The theory of the interference is given and yields values for the inclinations of the crystal faces in agreement with other measurements. A. H. W. BECK

537.533.74

3356. On the scattering of fast electrons. P. URBAN AND H. MITTER. Note in *Z. Naturforsch.*, **7a**, 818 (*Dec.*, 1952) *In German.*

For the scattering of fast electrons by a Coulomb field of charge Ze, the Born approximation cross-section is written down, including correction terms of order $Z\alpha$ and (approximately) those of order $(Z\alpha)^2$, as well as Schwinger's radiative corrections of order α, including the corrections due to low-energy bremsstrahlung. R. H. DALITZ

537.533.74

3357. On the theory of scattering of electrons by electrons. H. SALECKER. *Z. Naturforsch.*, **8a**, 16–19 (*Jan.*, 1953) *In German.*

Calculation of the radiative correction of Møller's formula using Feynman's propagation amplitude with structure factor $G(\lambda)$ [Feynman, Abstr. 2187 (1950)].

Taking $G(\lambda) = \delta(\lambda - \lambda_0)$ and λ_0 of the order of the classical electron radius, the corrections are negligible ($< 10\%$) unless the energy of the incident particle exceeds 10^9 eV in the laboratory system.

W. A. HEPNER

537.533.74

3358. Electron-electron scattering at 6·1 MeV. W. C. BARBER, G. E. BECKER AND E. L. CHU. *Phys. Rev.*, **89**, 950–7 (*March* 1, 1953).

The absolute differential cross-section for the scattering of 6·1 MeV electrons by the electrons in a beryllium foil has been measured at 90 degrees and 109 degrees in the centre-of-mass system. Electrons from a linear accelerator were first magnetically analysed and then collimated to form the incident beam. Electron-electron scattering events were detected by end-window Geiger counters connected in coincidence. The counter with the defining aperture was connected in coincidence (1) with a counter at the conjugate scattering-angle, lying in the plane determined by the incident beam and the scattering direction to the defining counter; and (2) with another counter at the conjugate angle, but lying outside this plane, thus counting only accidental coincidences. The number of e–e coincidences was then given by the difference between (1) and (2), with appreciable corrections arising from asymmetry in the background and from dead-time losses. These corrections required measurements of single and coincidence count rates with the scatterer in and out of the beam. The result at 109 degrees was 4·4% lower than that predicted by the Møller theory, with a standard deviation based on the number of counts recorded of $\pm 6\%$. At 90 degrees the expected standard deviation was $\pm 2\%$, and here the experimental result was 8% below the theoretical. The latter result suggests the possibility that the Møller theory overestimates the cross-section. However, consideration of the effects produced by radiative collisions, and of possible systematic errors in the experiment, leads to the conclusion that the experimental result is not incompatible with the Møller theory. A.

537.533.74

3359. The application of variational methods to scattering by ions. I. The elastic scattering of electrons by helium ions. B. H. BRANSDEN AND A. DALGARNO. *Proc. Phys. Soc.* [*London*] *A*, **66**, 268–77 (*March*, 1953).

The variational method is used to investigate the elastic scattering of slow electrons by the positive He ion. Zero order phases and wave functions found by this method are shown to agree, in general, with those found by numerical integrations of the wave equation, both when the wave function is of the "one-body" type and when it is of the correct symmetry. The inclusion in the trial wave function of a term involving the distance between the two electrons is found to lead to smaller phases. Detailed results are given for energies of the incident electron in the range 3–60 eV. A.

537.533.74

3360. Tables for second Born approximation scattering from various potential fields. L. MOWER. *Phys. Rev.*, **89**, 947–9 (*March* 1, 1953).

By means of a variational approach, the scattering amplitude for electron scattering from various potentials is calculated. Numerical values for the functions involved are tabulated as a function of energy and scattering angle. A.

537.534

3361. Acceleration of heavy ions to high energies. D. WALKER AND J. H. FREMLIN. *Nature* [*London*] **171**, 189–91 (*Jan.* 31, 1953).

A brief summary of earlier work on the cyclotron-acceleration of ions heavier than He^4 is given. The acceleration of ions of Be^9, C^{12}, C^{13}, N^{14}, N^{15}, O^{16} and Ne^{20} in the Birmingham cyclotron is reported and the mechanism of acceleration discussed. J. H. FREMLIN

537.534

3362. Ion optics in long, high voltage accelerator tubes. M. M. ELKIND. *Rev. sci. Instrum.*, **24**, 129–37 (*Feb.*, 1953).

In the past the ion optics of long, high voltage accelerator tubes has been a problem usually dealt with experimentally. Based upon a description of a high voltage tube presented by McKibben, a first-order focusing theory is developed essentially through the combined application of geometric optics and Gans's method. The analysis indicates the need for a description of the optical properties of the ion source and its associated electrodes before focusing, magnification, and other characteristics of the overall accelerator tube can be determined. The application of the theory to a tube and a simple source system is illustrated by an analysis of the focusing characteristics of the Rockefeller accelerator at the Massachusetts Institute of Technology. The results of this analysis yield computed focusing voltages in agreement with those used. A.

537.534 : 621.396.2 : 621.384.6

3363. Two systems for the synchronization of pulsed high-energy ion beams. G. VON DARDEL, E. HELLSTRAND AND C. TAYLOR. *Appl. sci. Res. B*, **3**, *No.* 1, 35–46 (1952).

When the ion source of a h.v. particle accelerator is modulated with pulses, e.g. for neutron time-of-flight studies, it is often necessary that synchronization should be maintained between these pulses and some electronic time-analysing equipment. If the ion source is in a h.v. electrode, some communication link to it must be provided. Two such links are described, one using a r.f. system at 450 Mc/s, the other using a pulsed beam of light. Both systems provide control over pulse width as well as pulse spacing. The r.f. system will transmit pulses down to 1 microsecond and is suitable for open accelerators. The optical system will transmit pulses down to 4 μsec and may be used with either open or pressurized accelerators. A.

537.534 : 621.384.61

3364. Perturbations in the magnetic deflector for synchro-cyclotrons. K. J. LE COUTEUR. *Proc. Phys. Soc.* [*London*] *B*, **66**, 25–32 (*Jan.* 1, 1953).

Previously [Abstr. 2754 (1952)] the linearized equation of motion of particles in the deflector were solved exactly; now the effect of non-linear terms, proportional to d^2H/dr^2, is evaluated approximately. The results indicate the tolerances on the field shape and the desirable radial position of the deflector. A.

537.534 : 621.384.612

3365. The operating principles of synchrotron accelerators. I. S. BLUMENTHAL. *Amer. J. Phys.*, **21**, 164–70 (*March*, 1953).

The synchrotron accelerator has many varieties. Some confusion exists in the widely scattered literature on particle accelerators as to the basic similarities and differences of the various types. This confusion is partly due to indistinct designation. In this review paper each variety is designated and described as a logical derivation from a previous type, and the basic principle of operation of each is described in turn. Factors governing oscillations in phase and in orbit are listed and described. Basic references are presented covering each point. A.

537.534.7

3366. Analysis of the linear r.f. mass spectrometer. P. A. REDHEAD AND C. R. CROWELL. *J. appl. Phys.*, **24**, 331–7 (*March*, 1953).

The linear r.f. mass spectrometer previously described [Abstr. 5842 (1952)] is analysed for small signal operation. The results are obtained in a closed form for any entrance phase where previously only a graphical solution for an optimized entrance phase was obtained. Expressions for resolving power and current efficiency are derived for both sine wave and square wave operation. It is shown that although high resolving power may be more readily obtained with square wave operation, the product of resolving power and efficiency is approximately the same for sine or square waves. Loss of resolving power caused by the thermal energies of the ions is shown to be less troublesome with square wave operation. A.

537.534.7

3367. Construction of a Mattauch type mass spectrograph of high resolving power. J. M. DELFOSSE AND M. NÈVE DE MÉVERGNIES. *Ann. Soc. Sci. Bruxelles*, **66**, *No.* 3, 156–61 (1952) *In French.*

A short description of the design (2 diagrams) with sample spectra (2 plates). First measurements indicate a resolving power of 12 000.

537.534.74

3368. Proton-proton scattering at intermediate energies. A. MARTIN AND L. VERLET. Letter in *Phys. Rev.*, **89**, 519 (*Jan.* 15, 1953).

Using Lévy's 4th-order potential (1952) with $G^2/4\pi = 10{\cdot}36 \pm 0{\cdot}02$ and core radius $r_c = (0{\cdot}38 \pm 0{\cdot}03)(\hbar/\mu c)$, consistent with n–p data, there is complete agreement with p–p angular distribution at 18·3 MeV and a 10% fit at 32 MeV. W. J. SWIATECKI

537.534.74

3369. A test for charge independence in high energy nucleon-nucleon scattering. B. A. JACOBSOHN. Letter in *Phys. Rev.*, **89**, 881 (*Feb.* 15, 1953).

If the scattering is charge independent, then the differential cross-section for p–p scattering at 90° must be equal to or less than four times the corresponding n–p cross-section. Although present experimental data conform to this inequality, it is possible that a breakdown may occur at energies above 300 MeV.

J. M. CASSELS

537.534.75 : 778.34

3370. The range-energy relation for protons and alpha-particles in diluted Ilford G5 emulsions. C. F. LEES, G. C. MORRISON AND W. G. V. ROSSER. *Proc. Phys. Soc.* [*London*] *A*, **66**, 13–16 (*Jan.*, 1953).

An account is given of the experimental determination of the range-energy relations for protons and α-particles in diluted Ilford G5 emulsions. The results are compared with those calculated by a method described by Webb. The range-energy relations for protons in the energy range from 2·5 MeV to 9 MeV can be represented by the empirical formulae $E = 0{\cdot}227R^{0{\cdot}602}$, $E = 0{\cdot}221R^{0{\cdot}595}$, $E = 0{\cdot}220R^{0{\cdot}583}$ for Ilford G5, G5 ×2 and G5 ×4 emulsions respectively, where E is in MeV and R in microns. A.

537.534.75 : 778.34

3371. The range correction for electron pick-up. W. H. BARKAS. *Phys. Rev.*, **89**, 1019–22 (*March* 1, 1953).

The extension of positive particle ranges caused by pick-up of electrons at low velocities has been studied in Ilford C2 emulsion. Ranges of Li^8 and B^8 nuclei were measured in emulsion and compared with tracks of He and H isotopes of the same velocity. The empirical range-energy relation adduced for light nuclei is: $Z^2R/M = F(T/M) + 0{\cdot}12Z^3$, for $\beta > 1{\cdot}04Z/137$. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

3372. Properties of argon-bromine counters. D. VAN ZOONEN AND G. PRAST, JR. *Appl. sci. Res. B*, **3**, *No.* 1, 1–17 (1952).

Argon-bromine counters are compared with argon-alcohol counters. The point is stressed that their properties change when the charge developed in the counter becomes equal to or greater than the charge originally present at the wire. The so-called oscillations are investigated and partially explained, as well as the delay in the build-up of a pulse, this delay being dependent on the overvoltage. A clear-cut picture of the mechanism of these counters cannot yet be given. A.

537.542

3373. The apparent dead time of a Geiger counter, measuring an intensity of radiation which varies periodically. H. DAAMS. *Appl. sci. Res. B*, **3**, *No.* 1, 29–34 (1952).

A formula is derived for correcting the effect of the dead time when measuring periodically varying intensities of radiation with a Geiger counter. This formula should also be valid when the period of the variation becomes equal to the dead time of the counter, in which case the apparent dead time is reduced appreciably. An experimental test shows that with increasing frequency of the variation the number of counts indeed goes through a maximum. A.

537.542

3374. Factors influencing the life of self-quenching counters. S. S. FRIEDLAND AND H. S. KATZENSTEIN. *Rev. sci. Instrum.*, **24**, 109–11 (*Feb.*, 1953).

Utilizing two counters connected together with a

valve, thus enabling the gas from one counter to be flushed into the other, the deterioration effects of the gas could be separated from those of the wire and cylinder. It is shown that the appearance of multiple pulses may be attributed to the dissociation fragments of the gas, whereas the changes in pulse height are dependent on the condition of the wire and cylinder. A.

537.542

3375. Ethylene and ethyl alcohol as quenching agents in external-cathode Geiger counters. R. L. Chasson and M. L. MacKnight. *Rev. sci. Instrum.*, **24**, 212–13 (*March*, 1953).

The manufacturing yield of acceptable external-cathode counters has been found to be 67% with ethylene–argon filling and 94% with ethyl alcohol-argon filling. Over 90% of the tubes that did not perform well with ethylene-argon performed well when refilled with alcohol-argon. A total of 444 counters enters into these statistics. Twenty rejected ethylene tubes were alternately refilled and tested with alcohol-argon and ethylene-argon. Results of several of such test cycles showed repeated success with alcohol and failure with ethylene. Deterioration of quality with counting-age was extremely non-uniform for ethylene tubes, and at the end of their useful lifetime they displayed extreme multiple-pulsing but no serious damage to the plateau slope. A temporary return to normal operating characteristics was observed for these tubes after inactive periods. This behaviour is explained in terms of the Paetow effect. A.

537.542 : 621.387.424

3376. A new Geiger-Müller apparatus for radiation measurements. A. Kübler and P. Nenning. *Siemens–Z.*, **26**, 351–7 (*Dec.*, 1952) *In German.*

After a brief description of G.M. tubes and counting methods, an outline is given of certain commercially available tubes and counting sets, with some discussion of scaling circuits, etc. J. D. CRAGGS

537.542

3377. A re-entrant thimble ionisation chamber. J. Sharpe and F. Wade. *Atomics* [*London*] **4**, 32–3, 48 (*Feb.*, 1953).

Describes a high pressure (30 atm.) ionization chamber with 4π geometry. 1 mC of Ra gives an ion current of $1{\cdot}9\times10^{-9}$ A and the background current of the unshielded chamber is 3×10^{-13} A. Constructional details are given. J. D. CRAGGS

537.542

3378. An automatic ionization chamber. H. V. Neher. *Rev. sci. Instrum.*, **24**, 99–102 (*Feb.*, 1953).

The ionization chamber described herein has the following characteristics: (1) It recharges itself after having collected a definite charge. (2) It generates a pulse at the instant of recharging that is easily amplified electronically. (3) The constant of the ionization chamber is independent of the constants of vacuum tubes but does depend on the constancy of a quartz fibre, the pressure of the gas and the potential of the charging battery. It has been successfully used to measure cosmic-ray ionization at balloon altitudes both in the United States and in northern Greenland. A.

537.542 : 537.567

The saturation curve for ionization measurements in pulsed radiation beams. *See Abstr.* 3395

537.542

3379. An apparatus for filling neutron counters with boron trifluoride. G. Cortellessa. *R.C. Ist. Super. Sanità*, **15**, *Pt III*, 168–80 (1952) *In Italian.*

537.542 : 621.318.572

3380. Counting pulses of various forms and occurrence intervals by electronic counters. N. F. Roberts and L. T. Wilson. *Austral. J. appl. Sci.*, **3**, 263–76 (*Dec.*, 1952).

Problems in counting pulses that are non-uniform to varying degrees with respect to shape, size and separation interval are discussed; and devices are suggested for obtaining maximum accuracy. Modifications to univibrator circuits are described which prevent retriggering during the recovery period, or provide for a retriggering characteristic that permits the recording of overlapping pulses under certain conditions, or both. A.

537.542 : 621.318.572

3381. Counting rate measurement by interval sampling. M. F. Crouch and G. E. Haynam. *Canad. J. Phys.*, **3**, 356–65 (*March*, 1953).

Two methods are described for measuring high counting rates with a counting device having a long resolving time. Both methods are based on the deliberate introduction of a large but calculable counting loss to transform a high counting rate to a lower rate. Formulae giving the counting rate in terms of the reduced rate are presented, together with formulae for the standard deviation of the counting rate. The performance of circuits used to study one of the methods is described, and a comparison is made with conventional rate measurement methods. It is found that, while the relative simplicity of equipment is gained at the expense of speed of measurement, the latter sacrifice is not as severe as might be expected. A.

537.542 : 621.395.645.018.75 : 621.38

3382. Background noise in ionization chamber pulse amplifiers. G. Valladas and A. Lévêque. *J. Phys. Radium*, **13**, 521–6 (*Nov.*, 1952) *In French.*

Depending on the use to which the chamber is put, the process of particle detection can be described in two ways. For these alternatives the transient response of the amplifier may be prescribed for optimum signal/noise ratio. In the case of (*a*) the circuit must provide integration of a voltage with respect to time and take the difference between a voltage and the same voltage delayed by a short interval. In case (*b*) a parabolic transient response is required. Practical approximations to these requirements are discussed. S. C. DUNN (R)

537.542

3383. A simple controlled Wilson chamber. M. Della Corte, T. Fazzini and S. Franchetti. *Ricerca sci.*, **22**, 1743–8 (*Sept.*, 1952) *In Italian.*

A cloud chamber of the diaphragm type, to be used counter-controlled in cosmic-ray work, is described. Details of the apparatus and in particular of the electronic circuits employed are given. A.

537.542

3384. A continuously sensitive diffusion cloud chamber for operation at four atmospheres. M. Snowden and A. R. Bevan. *J. sci. Instrum.*, **30**, 3–4 (*Jan.*, 1953).

A preliminary study of the behaviour of the cloud-chamber has been made to provide data for the design of large high pressure cloud-chambers for use in high-energy nuclear research. The design of the chamber and ancillary apparatus is described and observations on the performance with different operating conditions is reported. Satisfactory photographs of tracks were obtained using a ciné-camera with continuous illumination, and a typical photograph is shown. A.

537.543 : 621.318.572 : 621.385.83

3385. A decimal counter electron tube. D. L. Hollway. *Austral. J. Phys.*, **6**, 96–115 (*March*, 1953).

A scale-of-10 counter electron tube is described, in which incoming signals are counted by triggering a single electron beam through a closed sequence of 10 pairs of stable states. Each stable state results from potential drops maintained on deflecting electrodes by the distribution of the beam current. Current distributions and deflecting electrode systems of fivefold symmetry, which together develop rotating deflection fields suitable for counters, are considered and an expression is derived for the optimum proportions of the electrode system. Other possible applications of the basic principle, the "self-rotating beam," to special purpose tubes are indicated. A.

537.543 : 621.385

3386. Change of electron temperature in an electron beam. H. M. Mott-Smith. *J. appl. Phys.*, **24**, 249–54 (*March*, 1953).

The effect of electron encounters on the velocity distribution in an electron beam after passage through an accelerating grid is calculated by direct integration of the Boltzmann equation. It is found, with electron densities and velocities typical of travelling wave tubes and diodes, that the electron encounters have a negligible effect, that the formulae of the usual kinetic theory for heat conduction do not hold, and that the longitudinal component of the electron gas pressure is negligible. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

3387. On the ionization and energy loss of a relativistic ionizing particle in polarizable material. P. Budini. *Z. Naturforsch.*, **7a**, 722–5 (*Nov.*, 1952) *In German.*

It is shown that, for a polarizable medium, the energy distribution of the ionization for large impact parameters of a relativistic particle does not join continuously with that given by the Bethe–Bloch theory for subatomic distances, and the physical reason for this discrepancy is given. A general formula is then obtained for the specific primary ionization for large impact parameters. R. H. Dalitz

537.56 : 537.534.9 : 530.162

3388. Statistical fluctuations in ionization by 31·5 MeV protons. G. J. Igo, D. D. Clarke and R. M. Eisberg. Letter in *Phys. Rev.*, **89**, 879 (*Feb.* 15, 1953).

537.561

3389. Ionization and dissociation of methyl siloxanes by electron impact. V. H. Dibeler, F. L. Mohler and R. M. Reese. Letter in *J. chem. Phys.*, **21**, 180–1 (*Jan.*, 1953).

Mass spectra were taken of $(CH_3)_6Si_2O$ and $(CH_3)_8Si_3O_2$. Relative intensities for nominal electron energies of 70 V and appearance potentials are tabulated. The most abundant ion is that formed by the dissociation of one methyl radical and one electron. The appearance potential is 9·6 eV in both cases. The doubly charged ions formed by two such dissociations are also abundant: in the disiloxane the relative intensity is 12·4 and the appearance potential 25 V, in the trisiloxane 12·4 and 22 V resp. Some higher charged ions are also observed and identified. It is concluded that the siloxanes ionize usually removing one methyl radical for single ionization. They remove two such radicals for double and three for triple ionization.

A. J. Taylor

537.562

3390. A generalized ionization formula for plasmas. G. Elwert. *Z. Naturforsch.*, **7a**, 703–8 (*Nov.*, 1952) *In German.*

A theoretical paper concerned with the establishment of ionization balance in a gas discharge plasma. The phenomena allowed for include photoionization, radiative recombination, ionization by electrons, and three-body recombination processes. These effects are studied separately and together, with some discussion also of Saha's equation. J. D. Craggs

537.563

3391. Inelastic collisions of electrons in helium and Townsend's ionization coefficient. I. Abdelnabi and H. S. W. Massey. *Proc. Phys. Soc.* [*London*] *A*, **66**, 288–96 (*March*, 1953).

It is pointed out that the accuracy of the cross-sections observed by Maier–Leibniz for the excitation of He by slow electrons may be tested by using them to calculate the Townsend ionization coefficients α and comparing the results of such calculations with observed values. Information about the reliability of the difficult measurements of excitation cross-sections is essential to check attempts made to develop a satisfactory theory. To carry out this test it is necessary to extend and to some extent refine the work of Smit on the velocity distribution of electrons in He diffusing under the action of a uniform electric field F when inelastic collisions are allowed for. This has been done and numerical results have been obtained for $F/p = 10$ and 20 V/cm/mm Hg. The ionization coefficient has been measured for the higher values of F/p and agrees quite well with that calculated when Maier–Leibniz's cross-sections are used. The sensitivity of this test of the cross-sections was examined by calculating α assuming that Maier–Leibniz's values were respectively twice and one-half the correct value. It was found that the calculated value of α is nearly proportional to the size of the

assumed excitation cross-section (it was assumed throughout that the ionization cross-section is given correctly from Smit's observations). It is concluded that the observations of Maier-Leibniz may be used for checking theoretical determination of excitation cross-sections in He. A.

537.563

3392. Mass spectra of aliphatic amines. J. COLLIN. *Bull. Soc. Roy. Sci. Liège*, **21**, 446–56 (*Nov.*, 1952) *In French.*

537.563 : 539.155.2

3393. Mass spectra of the tetramethyl compounds of carbon silicon, germanium, tin, and lead. V. H. DIBELER. *J. Res. Nat. Bur. Stand.*, **49**, 235–9 (*Oct.*, 1952).

Mass spectra of $C(CH_3)_4$, $Si(CH_3)_4$, $Ge(CH_3)_4$, $Sn(CH_3)_4$ and $Pb(CH_3)_4$ were obtained with a Consolidated 21–103 mass spectrometer. Isotopic abundances of C, Si, Ge, Sn and Pb were obtained from the observed spectra and used to calculate the monoisotopic spectra. The mass spectra of the Group IV tetramethyls are qualitatively similar. The principal ion in each case results from the dissociation of one methyl group. The molecule ion and ions resulting from the dissociation of hydrogen atoms are rare. Hydrides of the atom ions and the mono-, di- and tri-methyl ions were observed. Some evidence is pointed out for the possible formation of the CH_3^+ ion and the $C_2H_5^+$ ion in neopentane as hydrides of the central carbon atom. A.

537.565

3394. A measurement of the drift velocity of electrons in the electrical field in argon–alcohol mixtures. L. COLLI AND M. T. DE LEONARDIS. *J. appl. Phys.*, **24**, 255–7 (*March*, 1953).

The measurement has been taken by observing on the screen of a triggered sweep oscillograph the rise time of pulses as given by α-particles in an ionization chamber. The results give, for the 10% mixture, a behaviour of the $w(E/p)$ function, of the $w = aE/p$ type up to $E/p = 2\ \mathrm{V\ cm^{-1}\ mm\ Hg^{-1}}$ values, and of the $w =$ const type for larger values of E/p. Measurements at 0·5 and 5% alcohol concentrations are also reported. A.

537.567 : 537.542

3395. The saturation curve for ionization measurements in pulsed radiation beams. J. W. BOAG. *Brit. J. Radiol.*, **25**, 649–50 (*Dec.*, 1952).

See Abstr. 404 (1951). Measurements were made with a plane-parallel ionization chamber at 4 different spacings, and at 2 different distances from a 8 MeV pulsed linear accelerator. The collection efficiency f is represented fairly well (except at very low values) by the expression $f = u^{-1} \log(1 + u)$, where $u = 1000\, rd^2/V$, and $r =$ dose per pulse (rontgens or e.s.u./cm³), $d =$ electrode spacing (cm), $V =$ collecting potential (volts). This agrees satisfactorily with the calculations of Abstr. 404 (1951).

537.571 : 536.48

3396. On a modification of Jaffé's theory of column-ionization. H. A. KRAMERS. *Physica*, **18**, 665–75 (*Oct.*, 1952).

A modification of Jaffé's theory of column-ionization has been developed, this theory being in contradiction with the results of ionization experiments in liquefied gases at low temperatures. A critical analysis of the importance of each term in the equation of motion reveals that in the case of low temperatures the diffusion term has to be omitted *ab initio*. This procedure gives rise to a solution which, for currents small compared with the saturation current, differs markedly from Jaffé's solution and which is in better agreement with the experimental results. A.

537.583

3397. Photoconductivity study of activation of barium oxide. H. B. DEVORE. *R.C.A. Rev.*, **13**, 453–63 (*Dec.*, 1952).

Photoconductivity studies have been made for barium oxide cathodes at various stages of thermionic activation, for the purpose of attempting to establish the donor energy levels. Changes occurring during activation are reflected in the development of the long-wavelength tail of the photoconductivity curve. For states of low activity, this tail has a threshold in the neighbourhood of 2·3 eV, and, with increasing thermionic activity, a second threshold at about 1·4 eV develops. The measurements are interpreted as indicating the development of donors at levels having these depths below the conduction band during the activation. Tentative explanations of the origin of these donors are advanced. A.

537.583

3398. Investigation of back diffusion of photoelectrons in various standard gases as it affects secondary electron emission coefficients. J. K. THEOBALD. *J. appl. Phys.*, **24**, 123–7 (*Feb.*, 1953).

The effect of back diffusion of photoelectrons of two energy distributions in standard molecular and inert gases has been measured, and the results applied to the analysis of the Thomson equation as a semi-empirical formula for correcting the measurements of the secondary emission coefficients in gaseous discharges. The method brings the results of Lauer and Molnar into satisfactory agreement. The effect of electron attachment is briefly discussed. A.

537.583 : 621.385.032.216

3399. Emission decay phenomena due to the contaminated anode. K. AMAKASU AND T. IMAI. Letter in *J. appl. Phys.*, **24**, 107–9 (*Jan.*, 1953).

Describes the behaviour of oxide cathodes in diodes with sliding anodes, which could be contaminated in various ways. The results can be explained by a model in which BaO is evaporated on the anode in the molecular state. The observed poisoning is an equilibrium condition obtained by balancing the rate of poisoning due to oxygen against the activation due to Ba re-evaporated from the anode. This dissociation energy for the contaminant was 5·0 eV.

A. H. W. BECK

537.583 : 621.385.032.216

3400. New dispenser type thermionic cathode. R. LEVI. Letter in *J. appl. Phys.*, **24**, 233 (*Feb.*, 1953).

A variant of the "L" cathode is described in which the active surface is the outside of a porous tungsten plug, containing the active material in the pores. The active material is a mixture of normal and basic Ba

aluminates, which have the advantage of yielding practically no gas. A. H. W. BECK

537.583 : 621.385.032.216

3401. Changes in secondary and thermionic emission from barium oxide during electron bombardment. J. WOODS AND D. A. WRIGHT. *Brit. J. appl. Phys.*, **4**, 56–60 (*Feb.*, 1953).

During electron bombardment, the secondary emission from films of barium oxide changes with time in a manner which depends on the film thickness. The changes are due to a reduction process forming an excess of metal within the oxide; subsequent oxidation restores the initial behaviour. The thermionic emission from the films also varies with thickness, and increases as the tendency of the secondary emission to decay increases. Electron bombardment at room temperature lowers the thermionic emission of a thin film by increasing the oxygen concentration at the outer surface, but at temperatures above 500°C this oxygen accumulation does not occur, and the reduction process is a very effective one for activating the thermionic emission. A.

COSMIC RAYS 537.591

537.591

3402. Constant height maintenance by aerostats at high altitude. P. DEMERS. *Canad. J. Phys.*, **31**, 366–9 (*March*, 1953) *In French.*

A simple procedure is described, using closed rubber balloons in combination with a medium-sized open Polythene balloon, which enabled emulsions sensitive to cosmic rays to be maintained at heights between 24 and 32 km for 9 to 10 hours. A.

537.591 : 537.542

3403. Spark counters for short time interval cosmic ray measurements. E. ROBINSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 73–8 (*Jan.*, 1953).

An original design of parallel plate spark counter, developed especially for use in cosmic-ray experiments involving the measurement of millimicrosecond time intervals, has a stable and trouble-free performance over many months of continuous operation. Distinctive features of the construction are the comparatively large sensitive areas and the sealed-off type of assembly in glass. The counter time resolution obtainable under normal operating conditions is 5 mμsec. By using statistical methods it is possible to resolve time intervals down to 1 mμsec. An illustration of this is afforded by measurements of the mean velocity of cosmic-ray particles in the sea-level flux. A.

537.591 : 537.542

3404. Short time interval measurements on pairs of associated cosmic ray particles. E. ROBINSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 79–84 (*Jan.*, 1953).

Twofold coincidence rates for associated pairs of cosmic-ray particles have been measured at sea level as a function of their (small) horizontal separation. The parallel plate spark counters used had a time resolution of 5×10^{-9} sec. Simultaneously with the rates, measurements of the time intervals between the arrival of the two particles at a given horizontal plane were made, both for counters in air and under 18 cm Pb. When allowance is made for the effect of spurious phenomena it is found that the coincidence rate falls off rapidly with increasing counter separation, that the particles forming the pairs are penetrating and that they have a mean delay between them which is significantly greater than the resolving time of the counters. A.

537.591.08 : 551.508.43

The use of a simple barograph in cosmic ray balloon flights. *See Abstr.* 3768

537.591.1

3405. Associated pairs of penetrating particles and other events observed at mountain altitudes with photographic emulsions. K. R. DIXIT. *Indian J. Phys.*, **26**, 243–53 (*May*, 1952).

Ilford nuclear emulsions exposed at two places in the Himalayas at altitudes of 11 500 ft and 14 300 ft have been studied. All the events, singles $> 100\ \mu$ and stars which are not obviously radioactive are recorded. The singles appear to be produced by some radiation which is travelling in a direction almost vertical, and which is twice as absorbable as the star-producing radiation. Observation of all stars leads us to expect that some stars which are normally excluded as of radioactive origin, on the criterion that a star smaller than sixfold is radioactive when all the six tracks are less than 60 μ, could have been produced by the cosmic radiation. The cosmic-ray stars appear to be produced in a cascade process. Rare events like associated penetrating particles are observed. Four events are observed which are interpreted as those in which a π-meson is produced by the interaction of V_0^1 particle with a lithium nucleus. The value of the average mass of V_0^1 calculated from these events comes out as 2166 times the electron mass. A.

537.591.1

3406. Study of the heavy primaries in the cosmic radiation. J. HÉBERT. *Ann. Acfas*, **18**, 119–20 (1952) *In French.*

Fifty-nine tracks of heavy particles have been observed in nuclear emulsions carried to a height of 110 000 ft and maintained at a constant orientation by means of a compass. The number of heavy nuclei was found to decrease as Z increased from 10 to 25. No directional asymmetry greater than the statistical errors could be detected. H. ELLIOT

537.591.1

3407. Further measurements of the ionization by energetic cosmic-ray μ-mesons. B. T. PRICE, D. WEST, J. BECKER, P. CHANSON, E. NAGEOTTE AND P. TREILLE. *Proc. Phys. Soc.* [*London*] *A*, **66**, 167–72 (*Feb.*, 1953).

The most probable specific ionization of energetic μ-mesons has been measured as a function of momentum, using proportional counters filled with a neon-methane mixture. The results confirm previous measurements [Abstr. 6601 (1952)] and are in good agreement with the theoretically predicted increase of specific ionization at high momenta. A.

537.591.15

3408. The barometer effect of large air showers. A. CITRON. *Z. Naturforsch.*, **7a**, 712–21; *Erratum*, 763 (*Nov.*, 1952) *In German.*

Dense showers were defined as those discharging

all of 5 simultaneously, thin as those discharging 3 or 4, out of 5 counter trays exposed at 1230 m altitude. The exponent of the density spectrum found was $-1{\cdot}38$. The barometer coeff. for dense showers was found to be 10–20% > for thin showers in winter; in summer they were not significantly different. No variation of shower frequency with sidereal time was detectable. A variation with solar time was possible, the mean intensity for hours 0–12 was systematically greater than that for the hours 12–24, the difference being $(0{\cdot}67 \pm 0{\cdot}3)\%$. E. P. GEORGE

537.591.15

3409. Some aspects of the altitude variation of extensive air showers. A. L. HODSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 49–64 (*Jan.*, 1953).

Gamma, the exponent of the density spectrum of extensive air showers, is found to increase from $1{\cdot}445 \pm 0{\cdot}014$ at sea level to $1{\cdot}549 \pm 0{\cdot}018$ at 26 000 ft. The values quoted are mean values for the density range 50–500 particles per square metre. The increase is considerably less than that predicted by cascade theory on the primary electron hypothesis. It is suggested that the discrepancy may be explained by the formation of secondary cascade showers in a nucleon cascade process. Extensive air showers recorded by a fixed experimental arrangement show a maximum frequency at about 26 000 ft (8000 m). At that altitude the shower rate is found to be 42 times the rate at sea level. The barometer coefficient of extensive air showers at sea level is found to be $-(9{\cdot}0 \pm 1{\cdot}1)\%$ per cm Hg. Details are given of the quenching and hodoscope circuits used with the counters. A.

537.591.15

3410. Penetrating particles in extensive air showers. A. L. HODSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 65–72 (*Jan.*, 1953).

Extensive penetrating showers observed under a transition layer of Pb 10 cm thick are approximately 300 times more frequent at 30 000 ft than at sea level. A tentative analysis of their altitude variation suggests that the mean attenuation length in air of the N.-component of extensive showers is of the order of 200 g/cm^2. It is shown that in extensive showers at 30 000 ft the fraction of particles which are penetrating is of the same order as at sea level. A.

537.591.3

3411. The absorption of the nucleon component of cosmic rays at geomagnetic latitude 21° S. J. G. ROEDERER. *Z. Naturforsch*, **7a**, 765–71 (*Dec.*, 1952) *In German.*

Ilford G5 plates were exposed at various altitudes in Argentina from 2630 m to 5330 m. The stars were grouped into various energy bands using Bristol formulae, and the absorption lengths then determined in the atmosphere as a function of energy, the results ranging from 170 ± 6 (0·15 to 1·0 BeV) to 130 ± 20 g/cm^{-2} (3 to 6 BeV). By comparison with the work of others, the latitude effect relative to the data at 48° N. is given as a function of energy.

E. P. GEORGE

537.591.3

3412. A search for irregularities in the absorption of cosmic rays in lead. G. R. HEYLAND AND W. E. DUNCANSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 33–9 (*Jan.*, 1953).

The integral absorption curve of cosmic rays has been examined at sea level up to a thickness of 365 cm of Pb. In the first place, the absorption curve was examined in sections using a control telescope method to reduce the effects of atmospheric variation. It was found, to an accuracy of within about 1%, that there was no deviation from a monotonically decreasing curve. By a second method two regions of the curve, namely 0–30 cm and 71–193 cm, were examined in greater detail. Five G.M. counter telescopes were employed so that five consecutive points on the absorption curve were determined simultaneously. No irregularities in the absorption curves for these two regions were found, and it was also shown for the 0–30 cm region that this was true whether the absorber was wholly above or wholly within the telescope. The fact that no irregularities were found in the 71–193 cm region (corresponding to a momentum range of about 1–3 kMeV/C for μ-mesons) indicates that the irregularities in the meson momentum spectrum suggested by Blackett, and by Glaser, Hamermesh and Safonov are probably due to poor statistics. A.

537.591.3

3413. Momentum distribution for cosmic ray mesons up to 6 kMeV/c. G. R. HEYLAND AND W. E. DUNCANSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 40–8 (*Jan.*, 1953).

The absorption curve and differential absorption curve have been determined for cosmic rays at sea level up to 365 cm (144 in) of Pb. Since similar curves were obtained for the differential absorption both by differentiating the absorption curve and by an anti-coincidence method, the absorption curve was corrected for accidentals, showers and scattering and used for subsequent determinations. The scattering correction is shown to be important. After subtraction of the soft component contribution from the absorption curve the momentum distribution for μ-mesons is determined by making use of the range-momentum relation. This curve rises above the Rossi curve for momenta below 0·4 kMeV/c reaching a rather sharp maximum at about 0·16 kMeV/c. It is suggested that there are several factors contributing to this difference: (i) the soft component may not have been separated out completely and may be making a small contribution to the present curve at the low end, (ii) in the present work the proton component has not been separated out and will make an effective contribution just in the region of the maximum and (iii) the effect of scattering may mean that the Rossi curve is rather low in this region. A.

537.591.5

3414. Determination of the latitude effect of the cosmic ray intensity by means of nuclear emulsions. M. MORAND, Y. AVIGNON, L. VAN ROSSUM AND R. DESPREZ. *C.R. Acad. Sci.* [*Paris*] **235**, 1639–41 (*Dec.* 22, 1952) *In French.*

The frequency of tracks with density 1·5 minimum or greater has been compared at geomagnetic latitudes 65° 40′ and 46° 10′ at a height of 1920 m, and the ratio is found to be $1{\cdot}060 \pm 0{\cdot}026$, the intensity being greatest at the high latitude station. H. ELLIOT

537.591.5

3415. Anisotropy of cosmic rays recorded in photographic emulsions at great altitude. P. DEMERS AND R. COURTEMANCHE. *Ann. Acfas.*, **18**, 120–2 (1952) *In French.*

The directional asymmetry of particles producing stars has been investigated using nuclear emulsions exposed at balloon altitudes and maintained at a constant orientation by means of a compass. It is concluded that the results are consistent with an excess of incident particles from the west as predicted by theory. H. ELLIOT

537.591.5

3416. Non-existence of periodic orbits in the Störmer problem for certain values of the parameter γ_1. R. DE VOGELAERE. *Ann. Acfas.*, **18**, 122–4 (1952) *In French.*

It is shown that if c is the lower limit of the values of γ_1 for which there exist periodic orbits for a charged particle in a dipole field, then $0{\cdot}35355 < c < 0{\cdot}78854$. H. ELLIOT

537.591.5

3417. East-west asymmetry of moderate-energy neutrons in the cosmic radiation. J. C. BARTON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 160–1 (*Feb.*, 1953).

An anticoincidence counter arrangement showed no significant asymmetry in the arrival of moderate-energy neutrons at sea level. It is concluded that these neutrons do not maintain the same direction as the primary cosmic-ray particles which gave rise to them. A.

537.591.8

3418. Neutron production in lead by cosmic rays. K. HOGREBE. *Z. Naturforsch.*, **7a**, 772–80 (*Dec.*, 1952) *In German.*

The production in Pb was studied up to a thickness of 31 cm, using a BF_3 counter. The attenuation lengths found were, for the total neutron-producing radiation 320 ± 35 g.cm^{-2}, and for the charged component 480 ± 120 g.cm^{-2}. $(18{\cdot}5 \pm 1)\%$ of the neutrons were produced by charged particles. The expected irregularity at 2 cm, due to γ–n processes, was smaller than the limits of error. A small effect was detected at 20 cm, probably connected with that found by Schopper for stars. E. P. GEORGE

MAGNETISM 538

538.082 : 621.317.443

3419. A vibrating reed microbalance for susceptibility measurements in weak fields. Y. L. YOUSEF. *J. appl. Phys.*, **4**, 46–9 (*Feb.*, 1953).

An alternating or a modulated magnetic field of subsonic frequency exerts on a small specimen a periodic force which is communicated to a non-resonant reed, which is thereby forced to vibrate, the motion being indicated by a selective microvibration detecting arrangement. An opposing electrostatic field of the same frequency can be suitably applied to the reed so as to nullify its vibrations, and may thus give a measure of the magnetic force. A force whose amplitude is only 0·01 dyne can be readily measured to an accuracy of about 1%. A.

538.083.9 : 621.317.44.029.6

3420. A microwave magnetometer. P. J. ALLEN. *Proc. Inst. Radio Engrs*, **41**, 100–4 (*Jan.*, 1953).

Faraday rotation in ferrites at microwave frequencies is applied experimentally to a new magnetometer technique expected to attain extreme sensitivity. The microwave output voltage is linearly related to the magnetic field. Sensitivity is a function of microwave carrier level, length and initial permeability of the ferrite rotator. Experimental response curves are given for two different rotator lengths. Magnetic increments of the order of 1 μ have been detected. The prospect of attaining the extreme sensitivity inherent in the microwave magnetometer principle suggests the magnetic detection possibilities of a micro-magnetometer. A.

538.11

3421. Some magnetic properties of metals. V. Magnetic behaviour of a cylindrical system of electrons for all magnetic fields. R. B. DINGLE. *Proc. Roy. Soc. A*, **216**, 118–42 (*Jan.* 7, 1953).

For Pt IV, see Abstr. 3694 (1952). The Wentzel–Kramers–Brillouin method is used to solve the Schrödinger equation for an electron moving in a uniform magnetic field H, the boundary of the system being a cylinder with its axis lying along the direction of the field. It is found that there are two entirely different types of wave-function possible, one type leading to the small Landau diamagnetism of large systems discussed in Pt I of this series, the other to the larger diamagnetism of small systems discussed in Pt IV. Taking into account the occupied states of both types, the steady (non-periodic) contributions to the magnetic susceptibility are derived for all fields in both the low- and high-temperature limits, and for most fields at intermediate temperatures. A.

538.113

3422. A note on the diamagnetism of free electrons. E. H. SONDHEIMER. Note in *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 744–6 (1952).

It is pointed out that the diamagnetism of a 2-dimensional system of electrons, like that of the 3-dimensional system, consists of a steady susceptibility together with terms which oscillate with the magnetic field. E. H. SONDHEIMER

538.114

3423. Theory of the antiferromagnetic resonance absorption in $CuCl_2 2H_2O$. K. YOSIDA. *Progr. theor. Phys.*, **7**, 425–32 (*May–June*, 1952).

T. Nagamiya [Abstr. 1110–11 (1952)] has developed a theory of antiferromagnetic resonance absorption in the case that the applied static field strength is weaker than the geometrical mean of the exchange field and the anisotropy field. In this paper his theory is extended so as to apply also to the case that the former field is stronger than the latter geometrical mean, and is compared with the experimental results obtained for $CuCl_2 2H_2O$ by Gorter *et al.* [Abstr. 6346 (1951)]. A.

538.114

3424. On the spin wave theory of magnetic susceptibility and resonance absorption in antiferromagnetics. T. NAKAMURA. *Progr. theor. Phys.*, **7**, 539–50 (*May–June*, 1952).

A theory of resonance absorption in antiferromagnetics based on the spin wave theory developed by Anderson and Kubo is presented. The obtained resonance frequencies are compared with the results of the classical theory by Nagamiya. In both cases the anisotropy energy has uniaxial symmetry. The absorption coefficient is also computed. The calculations of the resonance frequencies are then extended to antiferromagnetics having the anisotropy energy of orthorhombic symmetry. In the course of these calculations expressions were obtained for the magnetic susceptibility, using the obtained energy levels of the spin system which is subjected to a static magnetic field. They are in agreement with those which Kubo has already given by use of the method of statistical thermodynamics. A.

538.114

3425. Antiferromagnetism by the spin wave method. III. Application to more complex systems. J. M. ZIMAN. *Proc. Phys. Soc.* [*London*] *A*, **66**, 89–94 (*Jan.*, 1953).

For Pt II, see Abstr. 6618 (1952). The formulae developed in the previous parts by the author are applied to body-centred and face-centred cubic lattices, with various ratios of next-nearest to nearest-neighbour antiferromagnetic interactions between the spins. Luttinger's results for the ground states of the corresponding Ising models are obtained by a simplification of his method. The face-centred cubic lattice with only nearest-neighbour interactions is shown not to be antiferromagnetic. In other cases the temperatures are calculated and are found to be proportional to $S(2S+1)$, where S is the spin of the magnetic ion. The experimental values of θ/T_c can be explained only if superexchange between next-nearest neighbours is greater than the nearest-neighbour interaction in compounds like MnO, but is negligible, or favours parallel spins, in MnF_2 and FeF_2. A.

538.114

3426. Collective electron ferromagnetism: a generalization of the treatment and an analysis of experimental results. K. L. HUNT. *Proc. Roy. Soc. A*, **216**, 103–17 (*Jan.* 7, 1953).

The collective electron theory of ferromagnetism is extended to include in the expression for the energy associated with the magnetization a term in the fourth power of the magnetization. A second adjustable parameter, similar to the $k\theta'/\varepsilon_0$ of the Stoner treatment, is thus introduced. Detailed comparison with experiment of a number of properties of Ni, Ni–Co and Ni–Cu alloys, is carried out. A high degree of co-ordination of the properties of Ni is obtained by a suitable choice of the two parameters, which are thereby determined within fairly close limits. The temperature variation of electronic specific heat and spontaneous magnetization of Ni is quantitatively covered, as is the magnetocaloric temperature change accompanying changes in external field. The spontaneous magnetization, temperature curves of cubic Co and four Ni–Cu alloys are similarly covered, and a simple interpretation can be given of the adherence to the law of corresponding states of Ni–Co alloys and the deviation therefrom of the Ni–Cu alloys. The model accounts qualitatively for the field-magnetization isothermals and for the variation of the magnetocaloric temperature change with magnetization. A detailed examination shows that the differences between theory and observation, where they exist, are due to effects not covered by the collective electron theory. The main discrepancies can be accounted for on the assumption that a small fraction of the volume of the material is made up of groups of atoms of varying size with a Langevin distribution of their magnetic axes. These groups may be called small domains. The problem is complicated by the fact that the field values computed theoretically are critically dependent on the parameters, of which a sufficiently close estimate cannot be made. However, for particular values of both $k\theta'/\varepsilon_0$ and A a good fit with experiment over a wide temperature range is obtained when it is assumed that the domains are of sizes varying from 10^3 atoms upwards, the largest proportion of domains being of 10^4 to 10^5 atoms, and the volume occupied by such domains probably being much less than 10% of the total volume of material. It is shown that the hitherto unexplained large temperature variation, derived from the experimental results, in the value of $-1/\sigma(\partial E/\partial\sigma)_T$ corresponding to the Weiss molecular field coefficient, is an almost direct consequence of the basic physical premises of the collective electron treatment. A.

538.114 : 538.24

3427. The spontaneous magnetization of a two-dimensional rectangular Ising model. C. H. CHANG. Letter in *Phys. Rev.*, **88**, 1422 (*Dec.* 15, 1952).

Extends to a rectangular lattice the treatment of Yang [Abstr. 3719 (1952)] previously applied to a square lattice. E. P. WOHLFARTH

538.22

3428. High temperature susceptibility of permanent dipole lattices. R. ROSENBERG AND M. LAX. *J. chem. Phys.*, **21**, 424–8 (*March*, 1953).

Van Vleck's exact classical treatment of dipolar materials is modified and extended (for convenience, his expansion of the susceptibility χ in powers of T^{-1} is replaced by an expansion of the effective molecular polarizability α_s). The present procedure exhibits the dependence of the coefficients of T^{-p} on lattice sums over certain typical interactions within "clusters" of dipoles. This feature, together with an extension to the fourth-order term, sheds light on the analytic character as well as numerical accuracy of the spherical approximation. The exact treatment also provides a standard of comparison for all other approximation methods. The fourth-order coefficient is evaluated for a simple cubic arrangement of the dipoles, and for the Onsager liquid model. The spherical result, at least in the high temperature range, includes the most important types of interactions within clusters; it reproduces the exact series through the third-order term, and differs from the exact simple-cubic fourth-order term by only 5%. In addition, when evaluated for the Onsager liquid model, the spherical solution is apparently an improvement over Onsager's solution. A.

538.221

3429. The coercive force of carbon steel and Néel's theory. M. ASANUMA AND S. MIYAHARA. *J. Fac. Sci. Hokkaidô Univ. II*, **4**, 147–52 (*March*, 1952).

The theory was verified experimentally. Néel's theoretical formula for coercive force is given as the function of the size of non-ferromagnetic inclusion. The measured curve of coercive force was divided into a part due to internal stress and a part due to the size of non-ferromagnetic inclusion, the latter being compared with Néel's theoretical formula. This experimental result was in good agreement with theoretical one. A.

538.222

3430. The sextet ground-level in diluted iron–alum. II. P. H. E. MEIJER. *Physica*, **18**, 723–8 (*Oct.*, 1952).

For Pt I, see Abstr. 1953 (1952). Some more results of calculations on dilute iron–alum, based on the concept of the combined fields of trigonal and cubical symmetry, are given. They may serve for further exploration of these salts. A.

538.222

3431. Paramagnetic resonance absorption and dispersion of the susceptibility of some crystalline salt powders at a frequency of $9{\cdot}62\times10^9$ c/s. B. M. KOZYREV, S. G. SALIKHOV AND YU. YA. SHAMONIN. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 56–61 (1952) *In Russian.*

Cavity measurements of transmission amplitude and wavelength give relative values of χ' and χ'' as a function of H up to 5000 oersteds at 293°K. No appreciable absorption is found for $(NH_4)_2SO_4$. $FeSO_4.6H_2O$; $CoSO_4.7H_2O$; $CoCl_2.6H_2O$; $[Co(NH_3)_6]Cl_3$; $[Co(NH_3)_5.H_2O]Cl_3$; $[Co(NH_3)_5Cl]Cl_2$; $NiSO_4.7H_2O$; $NiCl_2.6H_2O$; $CuBr_2$; $Cu(CH_3COO)_2.2H_2O$ and $Cu(OH)_2$. For the even electron cases, Fe^{++}, Co^{+++}, Ni^{++} it is presumed that internal electric fields remove the degeneracy: for the odd electron cases Co^{++}, Cu^{++}, a spin lattice relaxation time $\leqslant 10^{-12}$ sec is also postulated. Weak broad absorption is found for Cr_2O_3; $Cr(OH)_3$; $KCr(SO_4)_2.12H_2O$; $[Cr(H_2O)_4Cl_2]Cl.2H_2O$; and $[Cr(H_2O)_5Cl_2]Cl_2.H_2O$, with several maxima due to crystal field interactions. Strong absorption, with various half-widths, and $g = 2{\cdot}00 \pm 0{\cdot}01$ for ions in the ${}^6S_{5/2}$ state in $MnSO_4$; $MnCO_3$; $Mn(CH_3COO)_2.2H_2O$; though $MnCl_2.4H_2O$ has $g = 2{\cdot}09$ and a very broad peak. For ${}^2D_{5/2}$ ions of Cu^{++} g varies from 2·23–2·11 with $CuCl_2.2H_2O$; $CuCl_2.2NH_4Cl.2H_2O$; $CuSO_4.5H_2O$; $Cu(NH_3)_4SO_4.H_2O$ and CuS. $CrCl_3$ has $g = 1{\cdot}99$ and a half-width at half height of 80 oersteds which disagrees with the value 305 found by Yu Ting and Williams [Abstr. 5579 (1951)] who may have used a hydrated salt. All χ' and χ'' values are mutually consistent within experimental error using the Altshuler formula [Abstr. 7086 (1951)].

D. H. WHIFFEN

538.222

3432. Nuclear magnetic resonance line width transition in aluminium. E. F. W. SEYMOUR. *Proc. Phys. Soc.* [*London*] *A*, **66**, 85–8 (*Jan.*, 1953).

The nuclear magnetic resonance absorption line due to Al^{27} in the metal exhibits a line width transition centred at 330°c. The connection with diffusion processes is discussed. A.

538.222

3433. A preliminary magnetic study of purple sulfur. T. FREUND, S. ADLER AND C. SPARROW. Letter in *J. chem. Phys.*, **21**, 180 (*Jan.*, 1953).

Describes measurements of the paramagnetic susceptibility of an (impure) sample of purple sulphur at low temperatures and of yellow sulphur above the transformation temperature (−190°c). The results indicate that purple sulphur is composed of S_2 molecules in the ${}^3\Sigma$ state. E. P. WOHLFARTH

538.222

3434. Calculation of the size of the nuclear paramagnetic absorption band in a liquid. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **236**, 198–200 (*Jan.* 12, 1953) *In French.*

Interference between the local field fluctuations and the "flip-flop" effect leads to a revised expression for the spin-medium relaxation time. D. H. WHIFFEN

538.222

3435. The proton magnetic resonance line in liquid crystals. R. D. SPENCE, H. A. MOSES AND P. L. JAIN. Letter in *J. chem. Phys.*, **21**, 380 (*Feb.*, 1953).

A line $< 0{\cdot}1$ gauss wide in liquid *p*-azoxyanisole splits to three broader, weaker peaks (3·3 gauss overall) in the liquid crystal. D. H. WHIFFEN

538.222

3436. Nuclear magnetic resonance of aligned radioactive nuclei. N. BLOEMBERGEN AND G. M. TEMMER. Letter in *Phys. Rev.*, **89**, 883 (*Feb.* 15, 1953).

An experiment is proposed in which the nuclear gyromagnetic ratio of radioactive isotopes will be determined from the reduction, by a radiofrequency field at the resonance of the radioactive nuclei, of the radiation anisotropy of the aligned nuclei.

L. PINCHERLE

538.222 : 541.67

3437. Magnetochemistry of the heaviest elements. VII. Sodium plutonyl acetate. J. K. DAWSON. *J. Chem. Soc.*, **1952**, 2705–7 (*July*).

For Pt VI, see Abstr. 7403 (1952). The magnetic susceptibility of Na plutonyl acetate, measured over the temperature range 90–300°K, follows the Curie law exactly and agrees with the theoretical spin-only value for two unpaired electrons. This is taken as evidence that the ground state of the plutonyl ion has a $6d^2$ electron configuration. A.

538.222 : 541.67

3438. The preparation and magnetic susceptibility of clathrate compounds of nitric oxide and of oxygen. D. F. EVANS AND R. E. RICHARDS. *J. Chem. Soc.*, **1952**, 3295–7 (*Aug.*).

Methods have been devised for preparing clathrate compounds of quinol and oxygen, and of quinol and nitric oxide. The specific susceptibilities of the compounds have been measured, and the values of χ for the enclosed molecules calculated. For oxygen in the clathrate compound, $\chi = 108{\cdot}8\times10^{-6}$, which agrees within experimental error with measurements in the gas phase. For nitric oxide in its compound, $\chi = 51{\cdot}_6\times10^{-6}$. This value is higher than the recorded results for gaseous nitric oxide, but the difference may not be significant. It is pointed out that the magnetic properties of these compounds at very low temperatures might be of interest. A.

538.24

3439. The initial magnetization of nickel under tension. B. N. Brockhouse. *Canad. J. Phys.*, **31**, 339–55 (*March*, 1953).

In an attempt to resolve apparent discrepancies in the literature the initial susceptibility (χ) and Rayleigh constant (a) of pure Ni wire were measured between room temperature and the Curie point under various tensions (Z). For annealed Ni the quantity χZ is independent of Z, as required by Becker's theory, if the stresses are applied in order of increasing magnitude and if no plastic deformation occurs. χ and a are found to be connected by Néel's relation $a = c\,\chi^2 J_3/J_s$. The same temperature dependence is shown by χZ as by the initial susceptibility of unstressed Ni given in the literature. At temperatures below 150°C the temperature dependence of χZ is consistent with the recent theory of Döring. At higher temperatures χZ increases monotonically to the Curie point but a smaller rate than Döring's low temperature theory predicts. This temperature dependence is in apparent conflict with Becker's theory and magnetostriction measurements of Döring and Kirkham. It is possible, but unlikely, that the conflict arises from the presence of textures in the various specimens. An appendix gives the textures of the wire specimens as found by neutron diffraction. A.

538.247

3440. Domains of reverse magnetization. L. F. Bates and D. H. Martin. *Proc. Phys. Soc.* [*London*] *A*, **66**, 162–6 (*Feb.*, 1953).

An experimental study by the powder deposit technique has been made of interesting domains of reverse magnetization which arise when an initially saturated crystal of silicon–iron is demagnetized. Two cases have been studied with the crystal (*a*) as perfect as possible, and (*b*) with an artificial defect made at one end to provide controlled demagnetization effects. They show that imperfections in the surface are very important in determining the observed demagnetization phenomena. The surfaces of the crystal may themselves act as imperfections. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.52 : 536.21

3441. Temperature gradients in inductively heated cylinders. R. J. Thorn and O. C. Simpson. *J. appl. Phys.*, **24**, 297–9 (*March*, 1953).

An exact expression for the temperature difference between the inside and outside of an infinitely long cylinder heated inductively has been derived in terms of Bessel functions. A numerical comparison shows that for small cylinders (radius about 0·3 cm) an assumed parabolic distribution of the magnetic intensity agrees with the exact solution within 2%. A.

538.53 : 621.318.4

3442. High power solenoids; stresses and stability. J. M. Daniels. *Brit. J. appl. Phys.*, **4**, 50–3 (*Feb.*, 1953).

An exact treatment is given of the stresses in a flat coil, and account is taken of the spacing between turns by treating the windings as a homogeneous anisotropic material. The results are discussed as a guide to the stresses in thick solenoids. This is followed by a treatment of the stability of the turns of a solenoid against spontaneous deformation, using the principle of virtual work, and criteria for stability are found. It is shown that, in the absence of elastic restraining forces, the outer turns of a thick solenoid would be unstable. A.

538.55 : 621.392.5

3443. Synthesis of unbalanced RLC networks. L. Weinberg. *J. appl. Phys.*, **24**, 300–6 (*March*, 1953).

A method is demonstrated for synthesizing an unbalanced RLC network with lossy coils, i.e., each inductance has an associated series resistance. The network realizes a minimum phase transfer function whose numerator and denominator are of degree not higher than the third and fourth, respectively, and whose poles and zeros may lie anywhere in the left half of the complex frequency plane. It is shown that in many cases higher degree functions may be realized as one network. For a transfer function of arbitrary degree, factoring into component transfer functions is carried out, each component having the above characteristics; the components are then realized separately and isolated from each other by vacuum tubes supplying gain. The method makes use of the following new features: 1. A breakdown of a Hurwitz polynomial into two Hurwitz polynomials so that a division by one of them yields a sum of unity plus a positive real RLC function, each of whose partial-fraction terms (complex poles taken in pairs, or course) is positive real. 2. An application of a network theorem which divides the desired network into two networks, thus simplifying the synthesis problem. 3. A method of zero shifting to any point in the left half-plane with at least one pair of complex poles. A further advantage of the procedure is that the network may be designed to possess input and output shunt capacitances so that tube capacitances may be automatically provided for. A.

538.551

3444. Three lecture room demonstrations in the field of electricity. B. G. Kolossvary. *Amer. J. Phys.*, **21**, 228–30 (*March*, 1953).

Semiquantitative verification of the impedance formula for series circuits containing inductance and capacitance, phase relations in similar circuits including the case of resonance, and a triode oscillator operating in the frequency range from 2 cycles/sec to 20 000 cycles/sec, all based on a dissectible transformer, are described. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

3445. On the characteristics of the electromagnetic properties of isotropic bodies. G. Toraldo Di Francia. *Atti Fond. Ronchi*, **6**, 253–62 (*Oct.*, 1951) *In Italian.*

It is shown that the modern circuit theory of the

electromagnetic field leads in a natural fashion to the introduction of a physical quantity, called *admittivity*, depending on the isotropic substance considered and on the frequency. It seems reasonable on the other hand to replace the conventional dielectric constant with a really constant quantity, independent of frequency. It is very easy in this way to see the analogy existing between the resonant frequency of an oscillating circuit and atomic absorption lines. A.

538.561 : 538.566.2

3446. A transient magnetic dipole source in a dissipative medium. J. R. WAIT. *J. appl. Phys.*, **24**, 341–3 (*March*, 1953).

The solution is given for the electric field of a small current-carrying loop which is immersed in a dissipative medium and is energized by a step-function current. Approximate expressions for the magnetic fields are also derived. The propagation of an electromagnetic pulse in seawater is then discussed. A.

538.565 : 621.3.018.3

3447. Forced oscillations with nonlinear restoring force. C. HAYASHI. *J. appl. Phys.*, **24**, 198–207 (*Feb.*, 1953).

Forced oscillations with nonlinear restoring force are studied in transient states as well as in steady states. The original differential equation characterized by a nonlinear term is transformed under certain restrictions to the following differential equation of the first order: $dy/dx = Y(x, y)/X(x, y)$. Following Poincaré and Bendixson, the singularities and the integral curves of the above equation are discussed, the former being correlated with the periodic states of oscillations, and the latter with the transient states of oscillations. The stability of the periodic solutions is determined in accordance with that of the singular points, viz., according to the roots of the characteristic equation. The integral curves yield the relationship between the given initial conditions and the periodic solutions. Thus, once the initial conditions are prescribed, the final periodic states which are started with those conditions can be foreseen. Harmonic oscillations and the subharmonic oscillation of order $\frac{1}{3}$ are studied. In both cases the theoretical results are compared with the experimental measurements carried out for an electric circuit containing a saturable iron core, and satisfactory agreement is found between them. A.

538.565 : 621.315.612.4 : 621.396.611.4

3448. Quasi-degenerated modes in high-ε dielectric cavities. H. M. SCHLICKE. *J. appl. Phys.*, **24**, 187–91 (*Feb.*, 1953).

Deals with resonance effects in circularly cylindrical solid bodies of high-ε dielectrics such as titanates, these bodies being either not metallized or partly or fully metallized by fired-on silver. The high dielectric constant has two pronounced effects: (*a*) Miniaturization, a linear reduction in size in the order of magnitude of 1/100, and (*b*) Realization of boundary conditions approaching infinite wave impedance. All four combinations of radial and axial wave impedance being zero (metallized) or infinite (interface dielectric/air) are investigated mathematically and experimentally. Special consideration is given to degenerated modes; that is, modes for which the axial dimensions of the cavity do not contribute to the resonance wavelength. Because of the inherent magnetic leakage through the dielectric, this is only conditionally true. These modes are therefore termed quasi degenerated. In contrast to conventional cavity theory dealing only with metallic boundaries, quasi-degenerated *TE* modes are realizable; namely, if the faces of the cylindrical cavities are not metallized. These cavities can be tuned by introducing magnetic rods into them or by application of conductive disks outside of them in the proper position. A novel type of aerial can be evolved from the $TE_{010}^{\infty\infty}$ mode, comprising a dielectric spiral encircling a magnetic rod. In many cases the relatively high temperature coefficient, dissipation factor, and noise level prevent for the time being the potential application of these high-ε dielectrics. A.

538.565 : 621.396.611.4

3449. Electromagnetic field expansions in loss-free cavities excited through holes. T. TEICHMANN AND E. P. WIGNER. *J. appl. Phys.*, **24**, 262–7 (*March*, 1953).

It is shown that the electromagnetic field in a loss-free cavity excited through holes cannot be completely expressed in terms of the short-circuit modes of the cavity satisfying the condition that the tangential component of the electric field is zero on the boundary of the cavity including the openings. For a complete expansion it is necessary to add an irrotational magnetic field, which contributes a term inversely proportional to the frequency, to the usual admittance matrix. If the cavity is presumed to include a reasonable portion of the guides feeding the openings, this irrotational component becomes almost diagonal. A.

538.565.5 : 621.3.011 : 621.396.611.3

3450. A coupling analog for nonlinear systems with more than one degree of freedom. C. A. LUDEKE AND R. T. EVANS. *J. appl. Phys.*, **24**, 119–22 (*Feb.*, 1953).

A simple electromechanical analogue for expressing the coupling between nonlinear oscillatory systems is constructed and checked. The strength of the coupling can be easily controlled by varying the output of a d.c. amplifier while the type of coupling is determined by the shape of an aperture in an integrating cylinder. The device has general applicability to analogues in which the motion of a component part can be translated into the motion of a mask before an integrating cylinder with a selected aperture. A.

538.566 : 535.14

3451. On the propagation of white light in a vacuum. P. POINCELOT. *C.R. Acad. Sci.* [*Paris*] **236**, 184–5 (*Jan.* 12, 1953) *In French.*

Using the method of Abstr. 8955 (1952) it is shown that provided the mass of the photon is assumed different from zero, a pulse of white light will propagate without deformation even though its spectral components have differing group velocities. It is concluded that if a white star becomes visible the emitted light will appear white before arrival and thus no conclusion can be drawn with regard to the mass of the photon. This is not the case for monochromatic rays. G. D. SIMS

538.566

3452. A rigorous treatment of the diffraction of electromagnetic waves by a plane grating. R. MÜLLER. *Z. Naturforsch.*, **8a**, 56–60 (*Jan.*, 1953) *In German.*

A general solution, for any given values of the various parameters involved, is found in the form of two Fredholm integral equations of the first kind. These equations represent the two distinct conditions of polarization and are of the same form as the integral equations for diffraction at a plane diaphragm in a rectangular guide. A. E. DE BARR

538.566 : 621.392.26

3453. Propagation in waveguides filled longitudinally with two or more dielectrics. L. G. CHAMBERS. *Brit. J. appl. Phys.*, **4**, 39–45 (*Feb.*, 1953).

A survey is made of all the work on inhomogeneously filled waveguides which has so far appeared. Particular attention is given to two cases of practical importance, namely the rectangular and circular waveguides. A.

538.566 : 621.396.671

3454. An alternative method of solving Hallén's integral equation and its application to antennas near resonance. R. KING. *J. appl. Phys.*, **24**, 140–7 (*Feb.*, 1953).

Hallén's complex integral equation for the current in a cylindrical aerial is separated into two real integral equations for the components of current in phase and in phase-quadrature with the driving voltage. Each of these equations is solved by iteration using zeroth-order currents and vector-potential differences to define expansion parameters. It is shown that for electrical half-lengths near odd multiples of a quarter-wavelength at least a third-order solution is required in order to determine accurately the component of current in phase with the driving voltage and the conductance. Conductances for a range of radii are evaluated by the new third-order formula and compared with the King–Middleton second-order values and with the experimental data of Hartig. The new formula agrees excellently with experimental results at $h = \lambda_0/4$, whereas the earlier second-order formula has by far its greatest per cent error—near 8 to 10%—in a small range near resonance. It is concluded that for aerials near resonance, just as for very short and very long aerials, adequate account must be taken in the iteration of both components of current. A.

538.566.2

3455. The refractive indices of water vapour, air, oxygen, nitrogen, hydrogen, deuterium and helium. L. ESSEN. *Proc. Phys. Soc.* [*London*] *B*, **66**, 189–93 (*March*, 1953).

The method described by Essen and Froome has been used to measure the refractive indices at 9200 Mc/s. The value of $(n-1)10^6$ obtained for water vapour at 10 mm Hg pressure at 20°C is 60·7 which is the same as the value obtained at 24 000 Mc/s, showing that the absorption line at 22 000 Mc/s has a negligible effect on refractive index. The values obtained for air, O and N also agree with those previously obtained within the limits of error and therefore confirm the earlier results. The values of $(n-1)10^6$ obtained for H and D are higher than those calculated by Ishiguro *et al.* by 2% and 3% respectively. The calculated values were expected to be a few per cent lower than the true values, and they are therefore supported by the experimental results. A.

538.566.2

3456. On the differential equation of electromagnetic rays in a heterogeneous absorbing ionized medium of slowly varying parameters. H. ARZELIES. *C.R. Acad. Sci.* [*Paris*] **235**, 1619–21 (*Dec.* 22, 1952) *In French.*

538.566.2 : 621.396.11

3457. A note on wave propagation through an inhomogeneous medium. G. A. HUFFORD. *J. appl. Phys.*, **24**, 268–70 (*March*, 1953).

A few formal observations are made concerning wave propagation through an inhomogeneous medium. A modification of Kirchhoff's formula is suggested and an integral equation derived which, if certain integrals can be evaluated, gives an estimate of the error made in the usual approximate methods. Applications are indicated to the equivalent earth's radius model and to the flat earth, modified index model. A.

538.566.2 : 551.594.5

3458. Theory of radio scattering from the aurora. R. K. MOORE. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation, No.* 3, 217–30 (*Aug.*, 1952).

Details of a theory, with mathematical appendix, that signals observed are scattered from the leading edges of rapidly advancing columns of ionization (of diameter ~50 cm) created by bundles of incoming, 1 MeV, auroral protons. The theory explains the observed fading spectra (akin to meteor "whistles") and the minimum range effect (no returns at ranges less than 400 km have been reported). The rate of advance of the ionized columns is of the same order of magnitude as that found by spectrographic observation. Calculations of electron densities are attempted but depend on the size of the columns. G. M. BROWN

538.566.2 : 621.396.11

3459. Reflexion coefficient of radio waves from frozen terrains. J. K. GARLICK. Letter in *Nature* [*London*] **171**, 259 (*Feb.* 7, 1953).

Measurements made by airborne transmitters and receivers on 1600 Mc/s (vertical incidence) over various terrains in Canada. Reflection from open-water (coefficient 0·83) was used as comparison standard. It was found that, whereas the reflection coefficients of frozen muskeg and barren gravel were about the same as that of dry desert sand (~0·20), that of deeply frozen heavily wooded land was very much less (~0·08). G. M. BROWN

538.566.2 : 621.396.812.3 : 621.396.11

3460. Some studies on random fading characteristics. R. B. BANERJI. *Proc. Phys. Soc.* [*London*] *B*, **66**, 105–14 (*Feb.*, 1953).

The theory of random signals, as applied by various workers to the phenomenon of random fading of pulses singly reflected from the ionosphere, is considered critically. It is shown that, contrary to the prevalent idea, the velocity distribution of fading

s independent of the power spectrum of the returned wave. This invalidates the ordinarily accepted explanation of certain observed departures from theory. An alternative explanation of these departures is given, which explanation is quantitative in character and can therefore be experimentally verified. The influence of a steady signal superposed on the randomly fading wave, on the velocity distribution of fading is investigated. It is found that unlike the effect on the amplitude distribution, the effect in this case is very small, resulting only in a very slight increase in the velocity of fading. An alternative method of determining the autocorrelation function of the fading pattern (from which the power spectrum of the returned wave can be derived by inverse Fourier transform) is given. This provides an alternative method of determining the velocity of drift of ionospheric irregularities. The method of deriving the theoretical power spectrum returned by drifting ionospheric irregularities has been improved upon, yielding a form of the power spectrum which appears to be more in accordance with observations. A.

538.566.3

3461. Influence of the terrestrial magnetic field on the absorption of short waves in the ionosphere (normal incidence). E. Argence, K. Rawer and K. Suchy. *C.R. Acad. Sci.* [*Paris*] **236**, 190–2 (*Jan.* 12, 1953) *In French.*

Using a formula previously developed by Argence and assuming the collisional frequency follows an exponential law, calculations of the coeff. of absorption k are made for a parabolic E-layer with critical frequency 3·5 Mc/s. The results are in good accord with those obtained by the more rigorous Appleton–Hartree formula, but are markedly different from those given by the Sellmeier formula which neglects the earth's magnetic field. However, the effective absorption of a ray reflected by the layer, $\int k \, . \, dz$, is little different as the overall magnetic field corrections roughly compensate. G. M. BROWN

538.566.3 : 621.396.11

3462. The limiting polarization of magneto-ionic waves. J. Feinstein. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation, No.* 3, 19–24 (*Aug.*, 1952).

Development of a first-order wave theory of limiting polarization for a wave entering an anisotropic medium with varying absorption. An attempt is made to investigate the interaction (neglected in ray theory) of the characteristic waves in the transition region in which the magneto-ionic splitting occurs. As a first approximation it is concluded that, for an exponential E-layer, ray theory begins to hold somewhere above 70 km for a frequency of 3 Mc/s.

G. M. BROWN (R)

538.566.3 : 621.396.11

3463. Plane waves in the ionosphere. H. B. Keller. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation, No.* 3, 42–9 (*Aug.*, 1952).

Details of a mathematical treatment of the solution of Maxwell's equations appropriate to the ionosphere. The upgoing and downcoming ordinary waves are strongly coupled so as to become essentially identical (i.e. "reflection"), while some coupling is also indicated between the ordinary and extraordinary waves. The latter point contradicts the literature.

G. M. BROWN (R)

538.566.3 : 621.396.11

3464. The polarization ellipse in the ionosphere. J. C. W. Scott. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation, No.* 3, 50–2 (*Aug.*, 1952).

The polarization ellipses in a wave-front propagated vertically in a horizontally stratified slowly varying medium are defined in terms of their shape (ratio of major to minor axis, ρ) and orientation (deviation of major axis from magnetic north, θ). The polarization can be expressed in terms of the plasma frequency, collisional frequency, longitudinal and transverse components of the gyrofrequency when these frequencies are all normalized with respect to the wave frequency. Graphs are given showing the changes in ρ and θ as the collisional and plasma frequencies are varied independently. G. M. BROWN (R)

538.566.3 : 621.396.11

3465. Effect of ionospheric irregularities on the variations of phase-path and amplitude of a downcoming wireless wave. S. N. Mitra. *J. sci. industr. Res.*, **11B**, 453–4 (*Nov.*, 1952).

The change of phase-path of a downcoming wave from the ionosphere is known to possess discontinuous breaks at times of rapid variations of the amplitude of the received signal. An experiment is described in the present note in which both the amplitude variation and the phase-path variation of the downcoming signal were simultaneously recorded on a moving film. It is shown that when the amplitude of the received signal was becoming zero due to a phase-interference of the waves scattered from moving ionospheric irregularities causing the fading, there was a discontinuity in the corresponding phase-trace of the downcoming signal. It is concluded that the same phenomenon which causes rapid fading is also responsible for the irregular behaviour of the phase-path of the downcoming signal. A.

538.566.3 : 621.396.11.029.55

3466. On the ionospheric propagation of decametre-waves in polar arctic regions. J. Bouchard. *C.R. Acad. Sci.* [*Paris*] **236**, 220–2 (*Jan.* 12, 1953) *In French.*

Systematic study of the propagation of decametre-waves over great distances shows that signals are particularly deformed when notable variations of the horizontal component of the earth's field are observed in France. The changes are 4–5 times more important in the zone of maximum auroral activity, and it is concluded that the disturbances result from a particular type of turbulence of the ionosphere in the polar arctic regions, associated with magnetic agitation. G. M. BROWN (R)

538.569.3

3467. A standing wave method for measuring electromagnetic absorption in polar liquids at frequencies of the order 3×10^9 c/s. V. I. Little. *Proc. Phys. Soc.* [*London*] *B*, **66**, 175–84 (*March*, 1953).

A method is described which yields an accuracy of within about $\pm 1\%$ in the measurement of attenuation constants of the order $0{\cdot}01$ cm^{-1} to $0{\cdot}5$ cm^{-}

Accurate results for water are obtained, contributing to the data available for this liquid at 21°C. In addition, some results for the absorption coefficient and dielectric constant of dilute solutions of water, and of ethyl alcohol in dioxan are provided. A.

538.569.4

3468. On the absorption of u.h.f. radio waves in solutions of cresols in benzene. G. S. KASTHA. *Indian J. Phys.*, **26**, 103–10 (*March*, 1952).

The absorption of u.h.f. radiowaves in the range 250–920 Mc/s in solutions of *o*-, *m*- and *p*-cresol in benzene has been investigated, using G.R. oscillator 1209-A and the optical method. It has been observed that the pure liquids exhibit an absorption band near about 800 Mc/s and when they are dissolved in benzene the height of the absorption band increases in the case of *m*- and *p*-cresol and diminishes in the case of *o*-cresol. Also the position of the band shifts slightly towards higher frequencies. On heating the liquids to about 85°C, similar results are obtained. It is concluded from these results that the absorption observed in the case of *o*-cresol is due to a dimer, whereas that observed in the case of the other two cresols is due to single molecules; and that with a rise of temperature or with dissolution in solvents the number of single molecules increases and that of dimers diminishes. The values of *a*, the radius of the rotor calculated according to Debye's theory, is about 3·2 Å in the case of *o*-cresol, 2·7 Å in the case of *m*-cresol and 2·4 Å in the case of *p*-cresol. It is pointed out that the radius of the rotor also is larger in the case of *o*-cresol and this may indicate that the rotor is a dimer. A.

MAGNETIC EFFECTS 538.6

538.632

3469. The Hall effect in titanium. G. W. SCOVIL. Letter in *J. appl. Phys.*, **24**, 226–7 (*Feb.*, 1953).

Preliminary measurements are reported and show a positive coefficient. This is explained by assuming that holes contribute to the conduction, that there is an overlapping of energy bands, and that the densities of free electrons and holes are $0{\cdot}3\times10^{21}$ cm^{-3} and $7{\cdot}5\times10^{21}$ cm^{-3} respectively. C. A. HOGARTH

538.632 : 669.783 : 621.314.7 : 621.318.1.013

3470. Hall effect modulators and "gyrators" employing magnetic field independent orientations in germanium. W. P. MASON, W. H. HEWITT AND R. F. WICK. *J. appl. Phys.*, **24**, 166–75 (*Feb.*, 1953).

Three uses for the Hall effect in germanium crystals are described. These are: (1) use of Hall effect probes in measuring magnetic flux, (2) use of Hall effect in crystals to produce a pure product modulator, and (3) use of Hall effect in germanium crystals to produce a non-reciprocal transmission. If the resistances are shunted around such gyrators, the transmission can be made zero in one direction and finite in the other. In all these applications use is made of a crystal orientation for which the cross magneto-resistance effects are zero and the Hall effect constant does not vary with field by more than 2% out to a flux density of 20 000 gausses. This orientation was located by making a phenomenological study of the magneto-resistance and Hall effect corrections for a cubic crystal and evaluating constants experimentally. Correction terms to fourth and fifth powers of the magnetic field have been obtained. A.

538.652

3471. Magnetostriction of some ferromagnetic alloys. E. W. LEE. *J. Iron Steel Inst.*, **171**, 160–4 (*June*, 1952).

A simple apparatus is described which comprises a double roller and mirror system and is capable of giving accurate measurements of magnetostriction of ferromagnetic rods. The apparatus was used to study the magnetostriction of some alloys, including the Ni–Co system; from the latter, some conclusions concerning the variation of λ_{100} with composition have been drawn. The temperature coefficients of magnetostriction of four Ni alloys have been measured. A.

538.652

3472. Magnetostriction. E. W. LEE. *Sci. Progr.*, **41**, 58–77 (*Jan.*, 1953).

A review article dealing with the following topics: Definition and discussion of the various effects, measurement, magnetostriction and magnetization, volume and linear magnetostriction, formal theory for single crystals, application to polycrystalline materials, effects of stress and other factors, such as temperature, composition and degree of order in alloys, and specimen shape. E. P. WOHLFARTH

THEORY OF SOLID STATE 539.11

539.11

3473. A quantum-statistical treatment of the internal photo-effect. H. MÜSER. *Z. Naturforsch.*, **7a**, 729–34 (*Nov.*, 1952) *In German.*

Owing to an internal photoeffect, electrons in matter are being raised from lower to higher energy levels at a constant rate. Treating this effect as a small perturbation, the energy distribution of the electrons in the material is discussed, especially when only two or three electron levels are important. R. H. DALITZ

539.11

3474. States of solid methane as inferred from nuclear magnetic resonance. K. TOMITA. *Phys. Rev.*, **89**, 429–38 (*Jan.* 15, 1953).

As there are different points of view concerning the molecular dynamical states in solid methane, especially concerning the λ-transition at 20·42°K, the manner in which the new method of nuclear magnetic resonance throws light on the problem has been investigated. Both the one-parameter theory and the method of perturbation were applied to the analysis of the proton resonance data given by Thomas, Alpert and Tovey [Abstr. 2899 (1951)]. The characteristic time τ_c for molecular reorientation was estimated from the spin-lattice relaxation data, and it was found that above 20°K molecules may be considered to reorient against some fixed hindrances due to neighbouring molecules. At about 65°K a marked alteration is present in the dominant mechanism of the above reorientation, which is considered to be either correlated or independent molecular rotation. However,

below 20°K most of the molecules seem to be in the ground state of rotational oscillation and occasionally (about 10^7 times per second) tunnel or flip to neighbouring equivalent orientations. It was proposed that discrimination should be made between two pictures of the local magnetic field, possibly in relation to the frequency of resonance. This idea was confirmed by reproducing the line width data. A perturbation calculation, assuming the $F\bar{4}3m$ arrangement of the molecules and taking account of the above situation, gave the entire shape of the absorption line, which was in close agreement with experimental data observed in the lowest temperature range. A.

539.11

3475. Electronic structure of the germanium crystal. F. Herman and J. Callaway. Letter in *Phys. Rev.*, **89**, 518 (*Jan.* 15, 1953).

The method of orthogonalized plane waves has been used to study the band structure of the Ge crystal. A crystal model constructed from isolated atoms arranged as a Ge lattice was used to determine the Coulomb potential. The treatment involves the one-electron approximation and neglects the effect of exchange. The energy gap at zero wave vector was found to be 1·45 eV—twice the experimentally determined (minimum) gap. P. T. LANDSBERG

539.11

3476. Combined pairs of vacancies in copper. J. H. Bartlett and G. J. Dienes. *Phys. Rev.*, **89**, 848–50 (*Feb.* 15, 1953).

An approximate theoretical calculation is given of the energy of dissociation of vacancy pairs in Cu and of the activation energy required for the motion of associated pairs. If two atoms have been removed from neighbouring lattice sites, the resulting double vacancy may be more stable than the configuration consisting of two single vacancies far apart. On the assumption that the lattice energy may be regarded as composed of contributions from pairs of atoms, the energy of dissociation of a double vacancy in Cu has been estimated as about 0·6 eV. Furthermore, if the interatomic potential energy be represented by a Morse function, the activation energy for the motion of a double vacancy through any face-centred cubic metal crystal is about one-half that for a single vacancy. Double vacancies are, therefore, expected to be stable and highly mobile in such metals. A.

539.11 : 536.75

3477. Entropy of electrons in metallic lattices. M. Dehlinger. *Z. Naturforsch.*, **8a**, 67–9 (*Jan.*, 1953) *In German.*

The author suggests the existence of an anomalous electronic specific heat which should occur as the Fermi level rises through a narrow band of permitted electronic states with rising temperature. He suggests a relation between this effect and the temperature dependent change from one allotropic modification of a given crystal (notably iron) to another.

P. T. LANDSBERG

539.11 : 538.114

3478. Energy of a Bloch wall on the band picture. E. P. Wohlfarth. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 1053–4 (*Dec.*, 1952).

A brief critical discussion of the physical principles underlying related work by Herring [Abstr. 4501, 7445 (1952)]. Gives an alternative derivation of the Bloch wall coefficient for a rectangular energy band [Abstr. 5555 (1951)] and contrasts the result with that derived by Herring. E. P. WOHLFARTH

539.11 : 539.132

3479. Determination of the surface energy of a metal by molecular orbitals. G. R. Baldock. *Proc. Phys. Soc.* [*London*] *A*, **66**, 2–12 (*Jan.*, 1953).

The electronic binding energy of a monovalent metal is calculated by means of the molecular approximation for the simple cubic lattice in one, two and three dimensions, and for the body-centred cubic lattice, in terms of the resonance integral β. The corresponding surface energy is deduced in each case. The effects of various improvements in the approximation are estimated, namely the inclusion of the overlap integral, the inclusion of next-nearest-neighbour interaction, and the modification of the Coulomb terms of surface atoms due to their special environment. The bond orders in the neighbourhood of the surface are determined and the relation between them and the binding energy is discussed. Numerical values of the surface tensions of the alkali metals are calculated and compared with previous results. It is found that the theory underestimates the surface tension by a factor of about 2, and it is concluded that the Coulomb term modification is the most important of the corrections studied. A.

539.11 : 548.7

3480. Comparison of Slater's and Peckar's treatments of perturbed periodic potentials. H. Winston. Letter in *Phys. Rev.*, **89**, 317 (*Jan.* 1, 1953).

Shows how Pekar's equation [Abstr. 1257 (1947)] can be derived from Slater's [Abstr. 3157 (1950)].

C. TURNER

MOLECULAR STRUCTURE 539.13

539.13

3481. Experiments on long-range attractive forces between macroscopic objects. J. T. G. Overbeek and M. J. Sparnaay. Letter in *J. Colloid Sci.*, **7**, 343–5 (*June*, 1952).

See Abstr. 3766 (1952). Experiments conducted with flat, highly polished glass and quartz plates, with or without Ag coating, have proved the existence of attraction forces between macroscopic objects. The force/distance dependence follows an inverse third-power law, with a tendency to a somewhat lower power than three. F. LACHMAN

539.13

3482. The recombination of atoms. I. Iodine atoms in the rare gases. M. I. Christie, R. G. W. Norrish and G. Porter. *Proc. Roy. Soc. A*, **216**, 152–65 (*Jan.* 22, 1953).

The recombination of I atoms, in the presence of 5 rare gases, has been studied directly by means of the flash technique. The thermolecular rate law $-d[I]/dt = k[I]^2[M]$ is accurately obeyed and the absolute rate constants k, at 20°C, are 1·73, 1·86, 2·42, 3·41 and $3·44 \times 10^{-32}$ ml.^{2} molecules^{-2} s^{-1} for M = He, Ne,

A, Kr and Xe respectively. These data are briefly discussed in terms of the various theories of thermolecular reactions. A.

539.13 : 533.7

3483. Intermolecular force and transport coefficients. B. N. SRIVASTAVA AND M. P. MADAN. Letter in *Nature* [*London*] **171,** 441–2 (*March* 7, 1953).

Accurate values for the force constants in the Lennard–Jones 12 : 6 potential energy function are deduced from thermal diffusion data. The force constants are found to vary slowly with temperature; theoretical reasons for this are given.

E. H. SONDHEIMER

539.13 : 541.64

3484. Molecular configuration of polyelectrolytes. P. J. FLORY. Letter in *J. chem. Phys.*, **21,** 162–3 (*Jan.*, 1953).

The problem of the expansion of polyelectrolyte molecules is treated here by consideration of osmotic effects of mobile ions. The polymer molecule is represented as a spherically symmetric distribution of units with approximately Gaussian density function. On the assumption that the osmotic forces cause the molecule to expand uniformly, a series relation is obtained for the factor by which all linear dimensions are altered. The principal ionic term of the series expansion is identical with that obtained formerly by the electrostatic free energy method.

A. J. TAYLOR

539.132

3485. Two-centre interaction integrals. III. H.-J. KOPINECK. *Z. Naturforsch.*, **7a,** 785–800 (*Dec.*, 1952) *In German.*

For Pt II, see Abstr. 8089 (1951). The overlap, transition, exchange, Coulomb and ion two-centre integrals with hydrogenlike 2*s*- and 2*p*-functions for equal effective nuclear charges are expressed in terms of standard integrals, and numerical values are tabulated. R. H. DALITZ

539.132

3486. Note on the generalized free-electron model of conjugated polycyclic hydrocarbons. J. S. GRIFFITH. Letter in *J. chem. Phys.*, **21,** 174 (*Jan.*, 1953).

Several authors have suggested a generalized free-electron model for such molecules. It is shown that the wave functions of this model correspond to an algebraic set of secular equations. This correspondence holds also for polycyclics with side chains, provided the free electron path along each side chain is taken to extend one bond-length beyond the last carbon nucleus. A. J. TAYLOR

539.132

3487. A contribution to the theory of light absorption of symmetrical polymethine dyes. K. FUKUI, C. NAGATA AND T. YONEZAWA. Letter in *J. chem. Phys.*, **21,** 186–7 (*Jan.*, 1953).

Kuhn (1948) derived a relation based on the free electron gas model, which explained the colours of symmetrical and unsymmetrical polymethines and polyenes. The agreement between calculated and experimental absorption maxima was not satisfactory, so that a new relation is derived, based on a model in which small perturbing potential barriers between atoms are taken into account. Wavelengths are calculated and tabulated together with the experimental values and the Kuhn values. These results give better agreement with experiment.

A. J. TAYLOR

539.132

3488. The calculation of error in quantum chemistry. A. LAFORGUE. *C.R. Acad. Sci.* [*Paris*] **236,** 202–3 (*Jan.* 12, 1953) *In French.*

A set of wave functions can always be found such that the energy is lower for the less accurate ones. Hence the accuracy of a wave function must not be deduced from a zero error of an observable.

J. JACOBS

539.132

3489. On the interaction of closed shells. H. MARGENAU AND P. ROSEN. *J. chem. Phys.*, **21,** 394–8 (*March*, 1953).

In calculating repulsive forces between closed shells, two essentially different methods have been used. It is shown in this paper that they should not be expected to give equal numerical results, and attention is called to some finer methodological points in the theory of exchange forces. Tables give numerical results for the interaction of neutral He atoms. A.

539.132

3490. On the radiofrequency spectrum of the components of a sodium chloride beam. The dimerization of the alkali halides. S. A. OCHS, R. E. COTÉ AND P. KUSCH. *J. chem. Phys.*, **21,** 459–66 (*March*, 1953).

The transitions $\Delta m_I = \pm 1$, $\Delta m_J = 0$ for both Na and Cl were studied at high magnetic field in a beam produced by the evaporation of NaCl. The observed spectra could not be fully described in terms of the known internal interactions of a diatomic molecule or the interaction of a diatomic molecule with an applied field. It is suggested that the unexplained features of the spectra result from the presence in the beam of molecules of the type $(NaCl)_2$. Similar effects have been observed in NaF and NaI. A.

539.132 : 535.343

Calculation of light absorption of acenes with the aid of the spreading electron gas model of H. Kuhn. *See Abstr.* 3118

539.132

3491. The dissociation energy of fluorine. P. W. GILLES AND J. L. MARGRAVE. Letter in *J. chem. Phys.*, **21,** 381–2 (*Feb.*, 1953).

Measurements of the pressure of a F sample as a function of temperature over the range 300–860°K have shown considerable agreement with calculated values in the 300–800°K range, while considerable divergences exist for temperatures above 800°K. The weighted average of dissociation energy values calculated on the assumption that the above discrepancies are due to dissociation of F_2 gives a value of $31{\cdot}5 \pm 0{\cdot}9$ kcal/mol. F. LACHMAN

539.132

3492. The energies of strained carbonium ions. J. L. FRANKLIN AND F. H. FIELD. *J. chem. Phys.*, **21,** 550–1 (*March*, 1953).

The appearance potentials of two sterically hindered non-planar carbonium ions (from bicyclo [2.2.1] heptyl bromide and bicyclo [2.2.2] octyl bromide)

re found to be higher than the appearance potential of an analogous planar carbonium ion. From these results it is inferred that in general the appearance potentials of unhindered ions correspond to the formation of the ions in essentially equilibrium configurations. A.

539.132

3493. Computation of intensities of vibrational transitions in the electronic ground state of a Morse anharmonic oscillator. A. RAHMAN. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 10, 967–74 (1952).

Transition moments for transitions between the vibrational states within a fixed electronic level of a Morse anharmonic oscillator have been established in terms of finite recurrence relations, following Manneback's [Abstr. 2017 (1952)] technique.

J. JACOBS

539.132

3494. Asymmetric internal rotational barriers about single bonds. N. W. LUFT. Letter in *J. chem. Phys.*, **21**, 179 (*Jan.*, 1953).

The stable configurations and the heights of asymmetric barriers may be estimated from a knowledge of the Fourier coefficients of the periodic rotational barrier and of the interaction coefficients of the charge distributions on remote sides of the axis of rotation. These may be deduced from symmetry considerations together with the values known for related molecules. The technique is applied to asymmetric Me and Cl derivatives of C_2H_6 and to $HO–NH_2$. H. H. GREENWOOD

539.132

3495. A vibration-rotation band of monodeuteromethane. D. R. J. BOYD AND H. W. THOMPSON. *Proc. Roy. Soc. A*, **216**, 143–52 (*Jan.* 22, 1953).

The fundamental vibration band of monodeuteromethane near 4·5 μ, connected with the stretching of the C–D bond, has been reinvestigated with very high dispersion. It provides a good example of well-resolved parallel-type band structure of a symmetric top molecule in which the K splitting of P and R lines is clearly seen. Alternations of intensity are also found in accordance with the nuclear spin of the 3 H atoms. The rotational constants B_0 and B_1 have been determined, giving r_0(C–H) = 1·0924 Å. The centrifugal stretching coefficient D_J and its variation in the different vibrational states have also been measured. Analysis of the K splitting of the R and P lines reveals an anomaly between the sets on the two sides of the band origin, which seems to suggest that some unforeseen molecular interaction is neglected in the method at present accepted for calculating the molecular rotational energy levels. A.

539.132

3496. The asymmetric rotor. XI. Hydrogen sulfide absorption in the regions 8700 cm^{-1} and 11 000 cm^{-1}. K. K. INNES, P. C. CROSS AND E. J. BAIR. *J. chem. Phys.*, **21**, 545–7 (*March*, 1953).

For Pt X, see Abstr. 1012 (1953). By the use of a 21 ft grating spectrograph and absorbing paths of up to 350 ft, 60 lines in the region from 10 870 cm^{-1} to 11 100 cm^{-1} have been measured and analysed as the rotational structure of an A-type band. It may be identified as the lower component of the resonating pair (n_σ, n_π, n_δ) = (131), (311). Most of the more than 80 H_2S absorption lines measured between 8560 and 8830 cm^{-1} have been assigned to an A-type band identified as the lower component of the (121), (301) resonating pair. Several additional lines definitely not due to water appear to indicate the existence of a superimposed B-type band having about the same upper state parameters, presumably the lower component of the pair (211), (031). In cm^{-1}, $\nu_0 = 8697·3$, $A^* = 10·29$, $B^* = 8·75$, $C^* = 4·48$, $\nu_{\mathcal{P}} = 11\,008·78$, $A^* = 10·197$, $B^* = 8·559$, $C^* = 4·411$. A.

539.132 : 541.632

3497. The configurations of rotational isomers and their normal frequencies. S.-I. MIZUSHIMA, T. SHIMANOUCHI, I. NAKAGAWA AND A. MIYAKE. *J. chem. Phys.*, **21**, 215–19 (*Feb.*, 1953).

Normal frequencies of molecular configurations of different azimuthal angles of internal rotation have been calculated for various molecules showing rotational isomerism. It has been shown that one can tell fairly accurately the value of azimuthal angle by comparing the observed frequencies (especially the skeletal deformation frequencies) with those calculated for different configurations. The sum rule for the rotational isomers similar to that for isotopic molecules has been derived and has been shown to be very useful in assigning the observed frequencies. The product rule for rotational isomers previously derived has also been applied to this problem and has been shown to be useful in determining the azimuthal angles of rotational isomers. A.

539.132

3498. High multiplicity states in diatomic molecules. K. SURYANARAYANA RAO. *Indian J. Phys.*, **26**, 254–61 (*May*, 1952).

Adopting Hill and Van Vleck's method (1928), expressions for the energy levels of electronic states of higher multiplicities belonging to general intermediate case have been derived. A.

539.132

3499. Nonadiabatic transitions. H. AROESTE. Letter in *J. chem. Phys.*, **21**, 161 (*Jan.*, 1953).

A molecular wave function is expanded by the Born–Oppenheimer method in terms of the parameter $k = (m/M)^{\frac{1}{4}}$ where m refers to electronic mass and M to nuclear mass. The perturbation matrix elements of the first order in k give adiabatic and non-adiabatic terms. The latter may in principle be calculated since they require only a knowledge of the zeroth order wave functions. H. H. GREENWOOD

539.132

3500. A $(K + 2)nd$ order formula for asymmetry doublets in rotational spectra. D. KIVELSON. *J. chem. Phys.*, **21**, 536–8 (*March*, 1953).

Higher order perturbation theory is used to derive a formula for K type doubling of the energy levels of a rigid asymmetric rotor. The result is $\Delta W = \Delta W_0[1 + \{A + BJ(J + 1) + CJ^2(J + 1)^2\}\beta^2]$, where ΔW_0 is the Wang Kth-order result for the splitting of the energy levels, β is an asymmetry parameter, and A, B, C are independent of the structural parameters and of the quantum number J. A, B, C, have been tabulated for all values of K up to $K = 14$. A.

539.132

3501. Excited electronic states and molecular vibrations of thiophosgene. J. DUCHESNE. *J. chem. Phys.*, **21**, 548–9 (*March*, 1953).

The most general vibration potential function of the lower excited electronic state of thiophosgene is computed and interpreted in terms of theory. It is shown that the π^* antibonding orbital is not far from being localized in the CS bond and that the S lone pair electrons play a great part in the angular rigidity of the molecule. A general rule for the behaviour of the sign of the cross terms is formulated. A preliminary study of the next excited state is undertaken and a correlation between some properties of the molecular orbitals of both states is made. A.

539.132

3502. Interatomic electric quadrupole-quadrupole coupling in salts of cerium. R. FINKELSTEIN AND A. MENCHER. *J. chem. Phys.*, **21**, 472–9 (*March*, 1953).

The magnetic properties of a Ce salt in the terms of one-atom (crystalline field) model has been calculated at temperatures greater than 1°K. Because the Ce ion is not in an S state, its electronic charge distribution has a quadrupole moment; the influence of interatomic electric quadrupole-quadrupole interactions on the magnetic moment and optical rotation at very low temperatures has been determined. In Ce ethylsulphate this coupling is antiferromagnetic with a characteristic temperature of $\tau = 0{\cdot}01\langle r^2\rangle^4$ degrees, where $\langle r^2\rangle^{\frac{1}{2}}$ is the r.m.s. radius of the $4f$ orbit in Å. This interaction may be at least partly responsible for a low temperature anomaly found by Becquerel, de Haas and van den Handel, as well as for the sharp increase in specific heat noticed during adiabatic demagnetization. In other salts τ may be of opposite sign (ferromagnetic case) and possibly much larger (~1°K). A.

539.132

3503. A free-electron model for discussing reactivity in unsaturated hydrocarbons. K. FUKUI, T. YONEZAWA AND C. NAGATA. Letter in *J. chem. Phys.*, **21**, 174–6 (*Jan.*, 1953).

The π-electron distributions are calculated by the free-electron model for each energy level of the butadiene and naphthalene systems. There is a qualitative parallelism between these results and those obtained by the LCAOMO treatment, especially in the distribution of the frontier electrons which occupy the highest occupied level, and have been particularly associated with the reactivity problem. In some cases the free electron method has the advantage of greater simplicity of calculation exemplified here by the conjugated polyene systems. H. H. GREENWOOD

539.132

3504. Natural hypsochromic shifts on phenyl substitution. B. PULLMAN, G. BERTHIER AND J. BAUDET. Letter in *J. chem. Phys.*, **21**, 188–9 (*Jan.*, 1953).

Such a shift can occur only in non-alternant hydrocarbons, where phenyl substitution produces charge displacements both in the original hydrocarbon and in the phenyl group. Molecular orbital calculations are reported for a number of compounds. J. JACOBS

539.132

3505. Application of the metallic model to the calculation of some interesting cyanines, ramifications being taken into account. S. NIKITINE AND S. G. EL KOMOSS. *C.R. Acad. Sci.* [*Paris*] **236**, 62–4 (*Jan.* 5, 1953) *In French.*

The ordinary metallic model is not satisfactory for the calculation of spectra for those molecules, where the π-electrons can travel along different paths of atoms. Here calculations include these ramifications. In first approximation no unknown parameter appears in the relations. The energy eigenvalues only depend upon the known length of the chain and upon boundary conditions required by the ramification points. For molecules with two planes of symmetry (four different kinds of wave functions), the electron transitions were calculated. There is good agreement with experimental values, as far as these are known. A. J. TAYLOR

539.132

3506. Theoretical and experimental study of the absorption spectra of some dyes. S. NIKITINE AND S. G. EL KOMOSS. *C.R. Acad. Sci.* [*Paris*] **236**, 279–81 (*Jan.* 19, 1953) *In French.*

By the same method as applied to cyanines (preceding abstract) the amines rhodamine B, rosamine and pyronine are investigated. These molecules are plane. The chains of atoms between the two amino groups are considered: there occurs one unknown parameter in the relation derived for the energy levels, as the extent to which the electronic wave function has to be considered with respect to the amine group is unknown, and has to be estimated. The electronic band wavelengths are calculated and compared with experimental data. There is good agreement except for the first ultraviolet band of rhodamine B, which cannot be interpreted. It is supposed that this band is originated by the outside group of the amine. Pyronine, which contains no outside group does not show any such band. A. J. TAYLOR

539.132

3507. Theoretical considerations concerning Hammett's equation. IV. Calculation of ρ-values. H. H. JAFFÉ. *J. chem. Phys.*, **21**, 415–19 (*March*, 1953).

For Pt III, see Abstr. 363 (1953). The assumption is made that the effect of a meta or para substituent X on the reactivity of a reacting centre Y in a compound depends only on the electron density change induced by the substituent in the atom at which Y is attached to R. Using this assumption relative values of Hammett's reaction constant (ρ) are calculated for a given reaction in several series of compounds having the above formula. The calculations require the computation of the electron density changes induced by substituents in the atom at which Y is attached to R. The computations are carried out by the semiempirical LCAO MO method for several cases where R and the benzene ring form part of a single conjugated system. The resulting relative ρ-values are compared with experimental data. Reasonable agreement is found. A.

539.132

3508. A semi-empirical theory of the electronic spectra and electronic structure of complex unsaturated molecules. I. R. PARISER AND R. G. PARR. *J. chem. Phys.*, **21**, 466–71 (*March*, 1953).

The theory is designed for the correlation and prediction of the wavelengths and intensities of the first main visible or ultraviolet absorption bands and other properties of complex unsaturated molecules, and preliminary application of the theory is made to ethylene and benzene. The theory is formulated in the language of the purely theoretical method of antisymmetrized products of molecular orbitals (in LCAO approximation), including configuration interaction, but departs from this theory in several essential respects. First, atomic orbital integrals involving the core Hamiltonian are expressed in terms of quantities which may be regarded as semi-empirical. Second, an approximation of zero differential overlap is employed, and an optional uniformly charged sphere representation of atomic π-orbitals is introduced, which greatly simplify the evaluation of electronic repulsion integrals and make applications to complex molecules containing hetero-atoms relatively simple. Finally, although the theory starts from the π-electron approximation, in which the unsaturation electrons are treated apart from the rest, provision is included for the adjustment of the σ-electrons to the π-electron distribution in a way which does not complicate the mathematics. Electronic energy levels in the theory are expressed in terms of ionization potentials of atoms, resonance integrals of bonds, Coulomb repulsion integrals between two π-electrons on the same atom and between two π-electrons on different atoms, and penetration integrals between π-electrons and neutral atoms. Preliminary applications to ethylene and benzene in which only the carbon-carbon resonance integral is treated as an empirical quantity show that the theory can reproduce the results of the purely theoretical method with very little labour. The reasonableness of considering all of the above quantities as semi-empirical is pointed out however. A.

539.132

3509. On the molecular-orbital theory of conjugated organic compounds with application to the perturbed benzene ring. P.-O. LÖWDIN. *J. chem. Phys.*, **21**, 496–515 (*March*, 1953).

The electronic structure of a molecular system is investigated by using the idea of molecular orbitals. The behaviour of the separate molecular orbitals and the orbital energies under the influence of the substitution of one or more heteroatoms, considered as perturbations, is examined. A series of quantities, separate charge orders, bond orders and mutabilities are introduced, giving information about some characteristic physical and chemical properties of the compound. The perturbation scheme is carried out explicitly to the second order in the energies and to the first order in the orbitals, and special attention is paid to the treatment of degenerate levels. The overlapping problem is fully discussed. The basic results are independent of any empirical parameters, and they may be used either in the naïve semi-empirical theory or in a more elaborate theoretical approach based on an antisymmetrized molecular wave function. As an example, numerical applications are carried out in detail on benzene. Separate charge orders, bond orders and mutabilities are tabulated, and orbital energies for a perturbed benzene ring with one or two heteroatoms are explicitly given. A.

539.132 : 541.5

3510. The molecular orbital theory of chemical valency. XII. The excited states of diatomic molecules. A. C. HURLEY AND J. LENNARD-JONES. *Proc. Roy. Soc. A*, **216**, 1–10 (*Jan.* 7, 1953).

For Pt XI, see Abstr, 5960 (1952). A method is developed for the solution of the wave equation for two electrons in the presence of two centres. The work of Lennard–Jones and Pople [Abstr. 2888 (1952)] on the ground state of such a system is generalized so as to apply to all the excited states. Full advantage is taken of the symmetry properties of the wave functions, both in three-dimensional and six-dimensional space, to reduce the wave equation to a number of component parts, each of a particular symmetry type. This leads to sets of equations with characteristic symmetry properties appropriate to singlet states and triplet states, whether even or odd, positive or negative in the standard notation ($^1\Sigma_g^-$). A.

539.132 : 541.5

3511. Chemical valency theory and the electronic structure of the methane molecule. C. R. MUELLER. *J. Amer. Chem. Soc.*, **74**, 3466–8 (*July* 20, 1952).

Two principal methods, the atomic and molecular orbital methods, have been used in attacking the problems of chemical valency theory. An alternative method, the semi-localized orbital approach, has been developed, and includes both of the previous methods as special cases. A semi-localized orbital calculation of the binding energy and electronic structure of methane is made. The bond energy from such a calculation is 160 kcal greater than that for the atomic orbital method. The latter gives a negative bond energy. The electronic structure of the methane molecule obtained from the semi-localized orbital method is quite different from that of either simpler approach. It is shown that the method gives a natural description of steric effects, resonance, heteropolar binding, inductive effect and has a formal analogy with classical valency theory. This is the first full-scale quantum mechanical treatment of the methane molecule as a 10-electron problem. A.

539.132 : 541.5

3512. Semi-localized orbitals. IV. Relationship of *n*-center orbitals, two-center orbitals and bond properties. C. R. MUELLER. *J. chem. Phys.*, **20**, 1600–4 (*Oct.*, 1952).

For Pt II, see Abstr. 2011 (1952); for Pt III, see preceding abstract. The relationship between *n*-centre orbitals, two-centre orbitals and bond properties is discussed from the standpoint of atomic, molecular and semi-localized orbital theory. The necessary restrictions on the transformation from the more general *n*-centre to the two-centre orbitals is also discussed and a practical computational method for molecular problems is suggested. The relationship of the atomic and molecular orbital theories of the

excited electronic states of molecules is also investigated. A.

539.133

3513. The system pyridine-pyrrole and hydrogen bonding. R. H. LINNELL. Letter in *J. chem. Phys.*, **21,** 179–80 (*Jan.*, 1953).

Viscosity and infrared measurements confirm results obtained previously which suggest the formation of a 1 : 1 pyridine-pyrrole complex due to hydrogen bonding between the pyrrole N–H and pyridine N. An equilibrium constant for the formation of the complex can be calculated from the optical density of the 2·86 micron unassociated N–H vibration characteristic of free pyrrole. H. H. GREENWOOD

539.133 : 535.343–14

The microwave spectrum and structure of methylene fluoride. *See Abstr.* 3136

539.133

3514. Mean square radius of randomly coiled molecular chains. R. A. SACK. Letter in *Nature* [*London*] **171,** 309 (*Feb.* 14, 1953).

A derivation for an unbranched chain, neglecting volume effects. For large n and no preferred directional tendency Debye's result is obtained.

J. JACOBS

539.133

3515. A classical model of molecular dipoles and polarizabilities. F. MATOSSI. *Z. Naturforsch.*, **8a,** 61–7 (*Jan.*, 1953) *In German.*

As, owing to the complex nature of atoms, most classical models of molecular dipoles are unsatisfactory for the investigation of a considerable number of phenomena simultaneously, a new model is constructed, which considers the interaction of induced dipoles in the molecule. It is assumed that atomic polarizabilities are dependent upon atomic distances. Screening factors have to be introduced in order to account for the heterogeneity of charge. The dipole moment (μ) is introduced as a function of charge, distance, atomic polarizabilities and screening factor. It describes the dipole as a superposition of a formal ionic dipole and an induced atomic dipole. A dynamic effective charge is defined as $\partial\mu/\partial r$, which is dependent upon the same variables as well as upon the (non-vanishing) derivatives of the polarizabilities. For homopolar diatomic molecules the relations become somewhat simpler. Several of the parameters in these relations can be found from the components of the molecular polarizability and their derivatives, as known by Rayleigh scattering and molecular refraction data. Some assumptions, however, have to be made in order to estimate the screening factors. Under these assumptions molecular constants have been calculated and tabulated for a number of molecules. With this model the i.r. absorption of homopolar molecules like FCl can also be explained. The phenomena connected with ortho-para or meta directing substituents in benzene are discussed: the agreement with experiment is much better than could be expected. The method can be applied to the investigation of dipole moments, i.r. intensities, Raman and Rayleigh depolarizations, molecular refractions and Kerr effects. A. J. TAYLOR

539.133

3516. On the statistical theory of crystallite length. M. DOLE. Letter in *J. chem. Phys.*, **21,** 174 (*Jan.*, 1953).

See Abstr. 5086 (1952), 371 (1953). In answer to Simha's paper it is pointed out that the differences between his and the author's equations are due to the fact that Simha includes zero groups. If this is taken into account there is complete agreement, but the result is not appreciably improved by the more refined method. A. J. TAYLOR

539.133 : 541.64

3517. The volume effect in polymer chains. T. B. GRIMLEY. Letter in *J. chem. Phys.*, **21,** 185–6 (*Jan.*, 1953).

Work based on the Fokker–Planck equation involves a probability function ψ for a link. This ψ may be related to a pair distribution function, which in turn can be found in terms of the distribution functions in a chain, by the methods of classical statistical methods. J. JACOBS

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

3518. On the question of the measurement of the spins of nuclei. A. S. KARAMYAN AND K. A. TER-MARTIROSYAN. *Zh. eksper. teor. Fiz.*, **22,** *No.* 1, 40–55 (1952) *In Russian.*

The energy shifts of the outer electronic levels and the projection in the direction of the applied magnetic field of the magnetic moments are calculated for $J > \frac{1}{2}$. Graphical results are given for atoms in a $P_{3/2}$ state for $I = 1, 2, 3, 4, \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$.

W. J. SWIATECKI

539.152.1

3519. The effect of the tensor force on the binding energy of the alpha-particle. J. IRVING. *Proc. Phys. Soc.* [*London*] *A*, **66,** 17–27 (*Jan.*, 1953).

The binding energy of the He^4 nucleus is calculated by the variation method, assuming charge-independent neutral two-body forces, using Yukawa wells, not necessarily of the same range, for the central and tensor parts of the interaction. The wave function chosen represents a mixture of the principle $^1S_0$ and the principal $^5D_0$ states, the radial wave functions being of a simple exponential type. With the nuclear parameters adjusted to fit the deuteron energy and quadrupole moment, and other low-energy data, it is found that the introduction of the tensor force greatly reduces the large value of the He^4 energy, obtained in the purely central force case. Whereas equal ranges yield a very small binding, the unequal ranges, which according to Pease and Feshbach fit the triton, give reasonable values for He^4. Thus it seems possible that a phenomenological two-body interaction of the above type may give consistent results in the two-, three- and four-body problems. For the triton the same type of wave function gives rather poor results, compared with another exponential function, used previously [Abstr. 8990 (1952)]. A.

539.152.1

3520. Classification of "radii" of α-emitting nuclei as function of the neutron excess *I*. S. ROSENBLUM AND M. VALADARES. *C.R. Acad. Sci.* [*Paris*] **236,** 196–8 (*Jan.* 12, 1953) *In French.*

Plots of radii against A for different A–$2Z$ reveal minima around $Z \sim 84$ and suggest the closing of a shell at $Z \sim 98$. W. J. SWIATECKI

539.152.1

3521. The tensor force interaction between a shell closed except for a single vacancy and an external nucleon. J. HOPE. Letter in *Phys. Rev.*, **89,** 884 (*Feb.* 15, 1953).

Expressions derived by an extension of Racah's tensor operator method are given for neutral, symmetric and charged isotopic spin dependency. L. PINCHERLE

539.152.1 : 539.172.4

3522. Nuclear constitution and the interpretation of fission phenomena. D. L. HILL AND J. A. WHEELER. *Phys. Rev.*, **89,** 1102–45 (*March* 1, 1953).

An attempt is made to correlate in a unified picture the features of the empirical evidence on nuclear constitution, some of which appear to require for their explanation the liquid drop model as others require the independent particle picture. As an idealized and exploratory basis for an inclusive description, the extreme saturation assumption has been adopted: potential on a typical nucleon in the nuclear interior nearly independent of the position of the other nucleons, this potential falling off in a small distance at the nuclear surface. In the resulting collective model of the nucleus a distinction is made between the nucleonic state of the system—as defined by the states occupied by the individual nucleons—and the state of vibration and rotation of the nucleus as a whole. On quantum-mechanical grounds it is shown how the kinetic energy of this motion receives an explanation in terms of the degrees of freedom of the individual particles. As in the electronic-vibrational-rotational description of molecular constitution, so in the case of the nucleus it is reasonable to think of the sums of the energies of the individual particle states, plus the sum of the interaction energies, as defining a potential energy of deformation as a function of the shape of the system. Different states of the totality of individual particles give rise to different potential energy surfaces. A given sheet touches one of the surfaces immediately above or below it only at certain isolated "funnels" as in the case of polyatomic molecules. For full validity of the collective model it is necessary that non-adiabatic transitions from one surface to another occur infrequently compared to the frequency of rotation and capillary oscillations, so that these collective motions have a well-defined existence. The mathematical consequences of the collective model have not been explored fully enough to tell whether this condition of self-consistency is fulfilled well or very roughly or not at all for any given excitation energy. The vibrational frequencies correspond in general terms to those predicted by the simple liquid drop model, with, however, certain characteristic quantum mechanical differences. Instances of the Franck–Condon principle have to be accepted, analogous to those in the molecular case. Discussed are some consequences of the collective model or of its liquid drop simplification for energy levels, compatibility of strong neutron capture with individual particle effects in binding, quadrupole moments, α-decay, fission thresholds, photofission, spontaneous fission, asymmetry in nuclear fission, hydrodynamics of the division process, fission α-particles and fragment excitation. A.

539.152.2

3523. The angular momenta of the excited states of Pt^{196}. R. M. STEFFEN. Letter in *Phys. Rev.*, **89,** 665 (*Feb.* 1, 1953).

The measured angular correlation function for the 0·330 and 0·358 MeV cascade γ-rays in Pt^{196} is consistent with the spins of the excited states and the ground state being 2, 2 and 0. The first transition (0·330 MeV) is a mixture of 95% quadrupole and 5% dipole radiation, the components having a phase difference of π. J. HUGHES

539.152.2

3524. Exchange magnetic moments of nuclei with almost closed shells of nucleons. R. W. COLE. Letter in *Phys. Rev.*, **89,** 883 (*Feb.* 15, 1953).

A detailed study for four nuclei seems to suggest that more research is needed before it can be asserted that there is an exchange contribution to the magnetic moments of nuclei. L. PINCHERLE

539.152.2

3525. Magnetic moments of Si^{29}, Si^{33}, Zn^{67}, As^{75}, Se^{77}, Te^{123} and Te^{125}. H. E. WEAVER, JR. *Phys. Rev.*, **89,** 923–30 (*March* 1, 1953).

An improved nuclear induction spectrometer has been employed for the detection and measurement of the resonances of several stable nuclei. The sign and value of the magnetic moments are listed. No diamagnetic correction has been applied. The sensitivity of the apparatus is indicated by the photographs of the output signal of H^2 and O^{17} which occur in water with a natural abundance of 0·02 and 0·04%, respectively. A.

539.153

3526. Concerning the sequence in the filling in of electronic levels of atoms. V. M. KLECHKOVSKIĬ. *Zh. eksper. teor. Fiz.*, **23,** *No.* 1 (7) 115–22 (1952) *In Russian.*

A new principle for the grouping of electronic levels of atoms is proposed, which is based on the unification into a single group of those levels having an equal value of the sum of the principle (n) and of the orbital (l) quantum numbers. It is shown that the application of this principle of grouping makes it possible to construct a rational system of electronic levels in atoms which reflects the actual relationship between the order of the filling in of levels with the increase in the atomic number of the element, not only for the beginning of the periodic table but throughout the table. The filling in of electronic levels occurs in the order of increasing $(n + l)$. Within each level, defined as the group with a constant $(n + l)$, the filling in of the sublevels occurs in the order of increasing n. The last sublevels of the $(n + l)$ group are filled with s-electrons, after which the following $(n + l)$ group is filled. The maximum number of electrons occupying the levels of a single $(n + l)$ group does not increase continuously with an increase

of the value of $n + l$, but in steps, giving the sequence: 2, 2, 8, 8, 18, 18, 32, which includes the repetition of the numbers 8 and 18, characteristic of a periodic system. In each period of the Mendeleev system there occurs a filling of the levels belonging to not more than 2 neighbouring $(n + l)$ groups. The boundaries of the filling in of $(n + l)$ groups of the levels and the boundaries of the periods (beginning with the second) are displaced only by two *s*-electrons, since all the periods which end in the filling in of the *p*-levels, begin with the filling of the *s*-level of the preceding $(n + l)$ group. E. RABKIN

539.153

3527. $(n + l)$ groups of terms in the spectra of alkali elements. V. M. KLECHKOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 4, 691–4 (1952) *In Russian.*

The author applies ideas developed in a previous paper (preceding abstract) to alkali elements. He considers effective quantum numbers and quantum defects and shows that his arrangement of grouping levels by $(n + l)$ instead of by n (main quantum number) has merits. Term diagrams comparing the use of n as a classifier to $(n + l)$ are given for rubidium. E. RABKIN

539.153

3528. The decay of resonance radiation by spontaneous emission. E. J. HELLUND. *Phys. Rev.*, **89**, 919–22 (*March* 1, 1953).

A critical examination of the theory of resonance radiation has been carried through, employing the mathematical technique of Laplace and Stieltjes transforms. Particular attention has been devoted to the question of the temporal behaviour of the excited state. With no restrictions on the interaction between atom and radiation field other than that it be real, and that processes of sufficiently high frequency contribute only negligible effects, one can prove that the probability amplitude of the excited state cannot decay according to the general law $\Sigma_{\mu,\nu} C_{\mu\nu} t^{\lambda_\mu} e^{-\beta_\nu t}$, where the λ_μ and β_ν are complex constants lying in the right half-plane and the $C_{\mu\nu}$ are arbitrary complex coefficients. The deviation from the law just cited can be termed a straggling phenomenon since exact analysis shows that the probability amplitude, for sufficiently long times, is greater than that defined according to the radioactive decay law. Rigorous analysis of the source of this apparently anomalous behaviour reveals the following explanation. Although the probability amplitude of the excited state is, strictly speaking, a functional of the interaction between the transition current in the atom and the photon states of the electromagnetic field, the essential features are determined principally by those states lying near the resonance frequency. Three elementary observations are immediately apparent. First, a particularly tractable analytical approximation for the interaction can be made such that the value of the actual interaction is reproduced at the resonance frequency and such that the behaviour for high and low frequency photon states is at least qualitatively correct. Exact solutions in closed form can be obtained for this interaction. Second, in terms of the preceding representation it is possible to show that, associated with the transition between two atomic states, one is presented with a concomitant picture of a damped oscillation of charge describable in purely classical terms. Third, this classical motion can be interpreted as forming a source function for a continuous stochastic process in terms of which one finally derives the representation of the probability amplitude of the excited state. The straggling phenomenon previously cited is therefore that associated with all diffusion processes. The consideration of the exact interaction leads to more involved diffusion phenomena but does not in any case permit a radioactive decay law. A.

539.153 : 537.564

3529. Photoionization of excited mercury atoms. B. M. YAVORSKIĬ. Letter in *Zh. eksper. teor. Fiz.*, *No.* 1(7), 126–7 (1952) *In Russian.*

The effective cross-section a_ν for the photoionization of the Hg atom in the 6^3P_0 position, considered as a 2-electron system in a centrally symmetrical screened field of the nucleus, using Slater wave functions, is calculated to be $6{\cdot}78 \times 10^{-18}$ cm^2. E. RABKIN

539.153

3530. The application of the method of the partial separation of variables to two equivalent *p*-electrons. A. P. YUTSIS. *Zh. eksper. teor. Fiz.*, **23**, *No.* 4(10), 357–70 (1952) *In Russian.*

A method is developed for the application of the partial separation of variables in the theory of Fok–Veselov–Petrashen to atoms with two valence *p*-electrons. The radial integrals are analysed in terms of which the total energy of an atom is expressed in the partial separation of variables after integrating with respect to the spin and angular variables. Methods are developed for the calculation of the integrals of the kinetic energy and of the integrals of the electrostatic exchange energy. Numerical results are given for the calculations by the partial separation of variables for He, Li^+ and Be^{++} in the $2p^2$ configurations. E. RABKIN

539.153

3531. The generalization of the theory of the partial separation of variables to the case of polyvalent atoms. A. P. YUTSIS. *Zh. eksper. teor. Fiz.*, **23**, *No.* 4(10), 371–80 (1952) *In Russian.*

A linear combination of determinants, expressing the wave function of the whole atom, is transformed by means of the Laplace theorem in such a manner that the quantum numbers of the inner electrons are found in the minors of the determinants, and the quantum numbers of the valence electrons in their algebraic complements. The total energy of the atom is expressed with the help of the wave function of the whole atom modified in this manner. The general expression obtained is adapted to the case in which the variables of the inner electrons can be completely separated, and for the valence electrons an approximation of the partial separation of variables is used. In this latter expression for the total energy of the atom the dependence on the spins in a general form is separated. E. RABKIN

539.153

3532. Nonradiative relativistic contribution to the magnetic moment of $^3S_1$ helium. W. PERL AND V. HUGHES. Letter in *Phys. Rev.*, **89**, 886 (*Feb.* 15, 1953).

The non-electrodynamic relativistic corrections to

he g-value for two electrons in a $^3S_1$ state are calculated, including the effects of the Breit interaction. The electrodynamic radiative corrections to the intrinsic electron magnetic moment are added to these for comparison with the experimental g-value.

R. H. DALITZ

539.153.4

3533. The Hartree–Fock equations for continuous states with applications to electron excitation of the ground configuration terms of O I. M. J. SEATON. *Phil. Trans A*, **245**, *No.* 901, 469–99 (1953).

Pt I is concerned with the general theory of anti-symmetric wave functions for continuous states of atomic systems. For an $(N + 1)$-electron system the complete wave function is expressed in terms of an expansion involving products of the N-electron core functions multiplied by free electron orbitals, the equations satisfied by the latter being obtained from the Schrödinger equation. It is shown that the only consistent means of obtaining anti-symmetric wave functions in approximate solutions is to make the expansion explicitly anti-symmetric. This procedure gives equations for the free-electron orbitals which are similar to bound-state Hartree–Fock equations. The further approximation of using Hartree–Fock wave functions for the core states is then discussed. Certain nl^qkl configurations are analysed in detail using a total angular momentum representation. It is shown that the equations may be uncoupled if the energy differences between the nl^q terms are neglected (exact resonance approximation), and that approximate solutions of the full coupled equations may be obtained in terms of the exact resonance solutions provided that a suitable normalization condition is used. Pt II is concerned with applications to electron excitation of the ground configuration terms of O I. Distorted wave approximations show that other effects are insignificant compared to the contribution from the p angular momentum component of the free orbitals, but give for this results which are too large by several orders of magnitude. The coupled equations for the p-wave are solved in an exact resonance approximation, with neglect of $1s$, $2s$ exchange interactions. At a check point an exact resonance solution including $1s$, $2s$ exchange terms is obtained, and finally a complete solution of the coupled equations. Inelastic collision cross-sections calculated from the exact resonance solutions are found to be 72% (without $1s$, $2s$ exchange) and 95% (with $1s$, $2s$ exchange) of the result from the complete solution. Final curves for the collision parameters, which rise to within 70% of the limit set by charge conservation, are considered to be of an accuracy approaching that of the Hartree–Fock method for bound-state problems. A final section is concerned with the contributions of the p-wave to elastic scattering of slow electrons by O I. A.

539.153.4

3534. The theory of the Thomas–Fermi electron density. J. S. PLASKETT. *Proc. Phys. Soc.* [*London*] **66**, 178–90 (*Feb.*, 1953).

A new modification of the Thomas–Fermi formula is derived which is similar to Weizsäcker's; this provides what is claimed to be a more plausible proof than usual of the Thomas–Fermi method. The method is applied to give a non-divergent relativistic approximation for $Z < 137/2$ and is used to demonstrate the incorrectness of the Thomas–Fermi–Dirac equation based on Fock's equations. Slater's approximation to Fock's equations is used to derive a Thomas–Fermi equation with exchange only differing from Dirac's by a change in Z. The solutions of this equation are re-interpreted and shown to be not unique, though always giving a positive electron density. A.

539.155.2 : 537–563

Mass spectra of the tetramethyl compounds of carbon, silicon, germanium, tin, and lead. *See Abstr.* 3393

539.155.2 : 541.14

3535. Photochemical enrichment of mercury 202. M. ZELIKOFF, L. M. ASCHENBRAND AND P. H. WYCKOFF. Letter in *J. chem. Phys.*, **21**, 376 (*Feb.*, 1953).

Describes the experimental apparatus used for the photochemical enrichment of Hg^{202}. The enrichment appeared to be highest (*c.* 20%) at low H_2O (or (or $H_2O + N_2$) pressure. F. LACHMAN

539.155.2 : 542.48

The separation of isotopes by fractional distillation. I. Fractionating columns for the enrichment of the heavy isotopes of oxygen in water. II. Determination of parameters from production data. Value of the unit process separation factor for the $H_2{}^{16}O$–$H_2{}^{18}O$ system. *See Abstr.* 3707–8

539.155.4

3536. Atomic mass of P^{31}. K. OGATA AND H. MATSUDA. Letter in *Phys. Rev.*, **89**, 333–4 (*Jan.* 1, 1953).

Using a modified Bainbridge–Jordan type of mass-spectrometer [Abstr. 1857 (1953)] the mass of P^{31} was obtained as $30{\cdot}983619 \pm 7$. The measurements are in agreement with those from nuclear reactions.

A. O. STANESBY

539.155.4

3537. The mass difference Si^{27}–Al^{27}. J. D. KINGTON, J. K. BAIR, R. R. CARLSON AND H. B. WILLARD. Letter in *Phys. Rev.*, **89**, 530 (*Jan.* 15, 1953).

The $Al^{27}(p, n)Si^{27}$ threshold was found to be $5{\cdot}819 \pm 0{\cdot}010$ MeV using the 5·5 MeV electrostatic generator at Oak Ridge; the calculated value of the mass difference Si^{27}–Al^{27} is then 0·00519 atomic mass units, and the Si^{27} disintegration energy $3{\cdot}81 \pm 0{\cdot}01$ MeV. A. O. STANESBY

RADIOACTIVITY. α-, β- AND γ-RAYS 539.16

539.16.08

3538. Carbon-14 sample preparation and counting techniques. Solid and liquid counting methods. D. R. SMITH. *Atomics* [*London*] **4**, 29–31, 38 (*Feb.*, 1953).

Describes and discusses the methods used.

F. R. HOLT

539.16.08

3539. The maintenance of radioactive standards with the 4π proportional counter. R. C. HAWKINGS, W. F. MERRITT AND J. H. CRAVEN. "*Maintenance of standards*" *symposium*, 35–45, 49–50 [*see Abstr.* 2972 (1953)].

A type of counter and its operation are described. It is very suitable for absolute β counting. Comparisons are made with other methods. F. R. HOLT

539.16.08

3540. Standardization of radioactive isotopes by coincidence and γ-ray ionization. W. E. PERRY. "*Maintenance of standards*" *symposium*, 45–50 [*see Abstr.* 2972 (1953)].

Methods used at the National Physical Laboratory for Co^{60} and Na^{24} are described and compared.

F. R. HOLT

539.163.1

3541. A search for the natural radioactivity of vanadium. S. G. COHEN AND R. BAUMINGER. Letter in *Bull. Res. Coun. Israel*, **2**, 195 (*Sept.*, 1952).

In the thought that the decay of natural V^{50} [Abstr. 2638, 3335 (1950)] by β-decay to Cr^{50}, or electron-capture to Ti^{50}, accounts for its low abundance, the radioactivity of about 5 g of natural V was measured in a 2π counter. No significant activity was found, which indicates $\sim 10^{21}$ yr for the lower limit of the half-life for either process.

539.163.1

3542. Halflife determination of ^{31}Si by a precision-method and a preliminary result on ^{83}Kr. L. J. DE VRIES, F. T. H. VERINGA AND J. CLAY. *Proc. K. Ned. Akad. Wetensch. B*, **55**, 303–8 (1952).

The half-lives of Si^{31} and Kr^{83} have been determined with an ionization-vessel and a rotating-condenser electrometer. Five samples were measured under different circumstances, the samples being prepared in two ways. The various precautions taken to obtain the accuracy of 0·3% claimed for each measurement, and the measurements made to obtain volume-recombination data are discussed. The mean value obtained for Si^{31} is 157·3 min ± 0·3%. A preliminary result on Kr^{83} is: 111·5 ± 0·15 min. A.

539.163.1

3543. The half live of P^{30}. K. BASKOVA AND A. KUDRYAVTSEVA. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 4(10) 483 (1952) *In Russian.*

Special experiments were carried out in order to establish more exactly the half-life of P^{30}, which was found to be 2·52 ± 0·02 min. E. RABKIN

539.163.1

3544. The assignment of the 6·7 hr isomeric transition of molybdenum to the isotope of mass 93. R. BERNAS AND J. BEYDON. *C.R. Acad. Sci.* [*Paris*] **236**, 194–6 (*Jan.* 12, 1953) *In French.*

Mass spectrographic separation of $Mo^{92,93,94}$ and analysis with a G.M. counter confirms the above assignment. W. J. SWIATECKI

539.163.1

3545. The half-life of Ca^{45}. C. F. G. DELANEY AND J. H. J. POOLE. Letter in *Phys. Rev.*, **89**, 529–30 (*Jan.* 15, 1953).

The ½-life was determined as 163·5 ± 4 days from measurements over 202 days using an end-window G.M. counter. A. O. STANESBY

539.163.1

3546. The half-life of W^{187}. G. G. EICHHOLZ. Letter in *Phys. Rev.*, **89**, 525–6 (*Jan.* 15, 1953).

The ½-life was redetermined as 23·85 ± 0·08 hr from measurements extending over 4 ½-lives, using an argon-filled pressure ionization chamber, vibrating reed electrometer, and pen recorder. A. O. STANESBY

539.163.1

3547. Spontaneous fission rate of Cf^{246}. E. K. HULET, S. G. THOMPSON AND A. GHIORSO. Letter in *Phys. Rev.*, **89**, 878–9 (*Feb.* 15, 1953).

The spontaneous fission ½-life of Cf^{246} was determined as 2100 ± 300 yr, in good agreement with the value calc. by extrapolation of the exponential dependence of the spontaneous fission rate of even-even nuclides upon Z^2/A. It is concluded that a subshell of 148 neutrons probably does not exist.

A. O. STANESBY

539.163.1

3548. A determination of the half lives of some magnetic dipole γ-ray transitions. R. L. GRAHAM AND R. E. BELL. *Canad. J. Phys.*, **31**, 377–92 (*March*, 1953).

A number of magnetic dipole γ-ray transitions have been studied using a coincidence circuit of short resolving time ($2\tau_0 = 2\times10^{-9}$ sec), a two lens single β-ray spectrometer, a pair of lens spectrometers placed end to end with coincidence counting of the focused radiations from a single source and a scintillation spectrometer. Lifetimes have been measured using the delayed coincidence method and where feasible conversion coefficients and K/L ratios obtained. Comparison is made with theoretical estimates of the lifetime-energy relation for $M1$ γ-ray transitions. The new results are as follows:

Nucleus	γ-Ray energy, keV	Half-life, sec	α_K	K/L
Te^{123}	159	$(1\cdot9 \pm 0\cdot3)\times10^{-10}$	—	—
Te^{125}	35·4	$(1\cdot58 \pm 0\cdot15)\times10^{-9}$	—	—
Cs^{133}	81	$(6\cdot0 \pm 0\cdot4)\times10^{-9}$	1·77	7·5
Cs^{135}	248	$(2\cdot8 \pm 0\cdot8)\times10^{-10}$	—	7·0
Pm^{147}	91·5	$(2\cdot44 \pm 0\cdot08)\times10^{-9}$	1·8	7·3
Tl^{208} (ThC″)	40 (*A* line)	$<7\times10^{-11}$	—	—
Bi^{212} (ThC)	238 (*F* line)	$<2\times10^{-11}$	—	—

A.

539.163.2

3549. Radiations from Zr^{97} and Nb^{97}. C. E. MANDEVILLE, E. SHAPIRO, R. I. MENDENHALL, E. R. ZUCKER AND G. L. CONKLIN. *J. Franklin Inst.*, **254**, 381–90 (*Nov.*, 1952).

$Zr^{96}O_2$ (isotopic concentration 90%) was irradiated by slow neutrons in the Oak Ridge pile. The half-period of the Nb daughter element, chemically separated from Zr, was found to be 72·1 ± 0·7 min

and that of Zr^{97} to be $17{\cdot}0 \pm 0{\cdot}2$ hr. By aluminium absorption and Feather analysis, maximum β-ray energies of 2·50 and 1·40 MeV were measured for parent and daughter element, respectively. Lead absorption of the quantum radiations of the equilibrium mixture indicated a γ-ray at 0·74 MeV as well as a softer component. Coincidence absorption yielded a maximum γ-ray energy of 1·42 MeV. The β-γ coincidence rate of Nb^{97} was constant, independent of the β-ray energy and of such magnitude as to suggest that each β-ray is followed on the average by 0·7 MeV of γ-ray energy. The β-γ coincidence rate of the equilibrium mixture showed that the hard β-rays of Zr^{97} proceed directly to the metastable state of Nb^{97}. Very few β-rays of Zr^{97} are in immediate coincidence with any γ-radiation. A.

539.163.2

3550. Radiations from arsenic 70. B. Ververk and A. H. W. Aten, Jr. Letter in *Physica*, **18**, 974–5 (*Nov.*, 1952).

As^{70} was obtained by irradiation of Ge oxide with 26 MeV deuterons; the ½-life is 52 ± 1 min, and the max. positron energy 2·7 MeV (Al absorption); the ratio $K/\beta^+ \gtrsim 0{\cdot}2$, and hard γ-radiation is also present in addition to the annihilation radiation.

A. O. STANESBY

539.163.2

3551. Some remarks about the decay of ^{237}U. A. H. Wapstra, M. Sterk and R. E. W. Kropveld. Letter in *Physica*, **18**, 980–1 (*Nov.*, 1952).

Reports preliminary results of a now discontinued investigation of the γ-ray spectrum of U^{237}, using a NaI(Tl) scintillation spectrograph. A. O. STANESBY

539.163.2

3552. The disintegration of Zr^{95} and Nb^{95}. H. Slätis and L. Zappa. *Ark. Fys.*, **6**, *Paper* 9, 81–93 (1952).

The β- and γ-radiations of Zr^{95}, Nb^{95} and Nb^{95m} (½-life 84 ± 2 hr) were examined using an intermediate image β-spectrometer and a scintillation γ-spectrometer. The *ft*-values for the β-transitions, and internal conversion coeffs. for the γ-radiations, were determined; the decay schemes are in general agreement with earlier work. A. O. STANESBY

539.163.2

3553. The degree of coherence in the interior of a radioactive distribution. J. Thibaud. *C.R. Acad. Sci. [Paris]* **236**, 66–8 (*Jan.* 5, 1953) *In French.*

539.163.2

3554. New long-lived magnesium-28 isotope. R. K. Sheline and N. R. Johnson. Letter in *Phys. Rev.*, **89**, 520 (*Jan.* 15, 1953).

A β-emitter with a ½-life of 21 hr was produced by irradiation of Si with γ-rays from a 100 MeV betatron, and of Mg with 39 MeV α-particles; the activity is assigned to Mg^{28}. A. O. STANESBY

539.163.2

3555. Angular correlation in the decay of Li^8. C. M. Class and S. S. Hanna. Letter in *Phys. Rev.*, **89**, 877 (*Feb.* 15, 1953).

The β-α angular correlation for the reaction $Li^8(\beta)Be^{8*}(\alpha)He^4$ was measured, and is of the form $1 + A_2 \cos^2\theta$, A_2 increasing with increasing β-particle energy, in accordance with theoretical expectation. Spins and parities favoured are 3−, 2+, 0+ for Li^8–Be^8–He^4 resp. [see also Abstr. 5703 (1951)].

A. O. STANESBY

539.163.2

3556. An upper limit for atomic orbital electron ejection accompanying *K*-capture in Fe^{55}. F. T. Porter and H. P. Hoiz. *Phys. Rev.*, **89**, 938–40 (*March* 1, 1953).

An upper limit has been determined for the number of atomic orbital electrons ejected during the decay of Fe^{55} by orbital capture. From cloud-chamber observations it is concluded that less than $0{\cdot}6 \times 10^{-6}$ electron are ejected per disintegration with energies in the range 30 keV to 205 keV. The theoretical prediction gives the order of 10^{-6} electron per disintegration for the frequency of the process in the energy range studied. A.

539.164

3557. On the new theory of alpha-decay. M. L. Chaudhury. *Indian J. Phys.*, **26**, 186–96 (*April*, 1952).

A detailed discussion of the implications of the recent theory of α-decay by Kar and Chaudhury [Abstr. 6422 (1951)] is made on the following points. (1) A theoretical formula for the nuclear radius independent of λ, has been obtained. The values of nuclear radii calculated from this formula are discussed and compared with those assumed in the old theories of α-decay. (2) It is shown from the new theory that the spacing of the nuclear energy levels in the radioactive region is of the order of only several volts, instead of about 10^5 eV as obtained from the previous theory of α-decay. The new values of level spacing is in agreement with those expected from the trend of the spacing observed in the experiments of resonance capture of neutrons by elements of atomic weight up to about 200. (3) The nature of variation of the ratio of anomalous scattering to normal scattering indicates the existence of the extra-nuclear potential of Yukawa type introduced in the new theory. (4) The experiments of Chang on the α-ray spectra of Po^{210} and Ra^{226} which are reported to be "in serious disagreement" with the α-decay theory of Gamow and of others, have been discussed in the light of the new theory. The effect of the extra-nuclear field introduced has been useful in explaining the above disagreement in a qualitative way. A.

539.165

3558. Cross terms in β decay. O. Kofoed-Hansen and A. Winther. Letter in *Phys. Rev.*, **89**, 526 (*Jan.* 15, 1953).

These terms, the "Fierz" terms, between *S* and *V* and between *T* and *A* interaction, are usually assumed to vanish. This assumption is not always justified, and precision measurements of the shape of allowed β-spectra with high maximum energy are very desirable. F. R. HOLT

539.165

3559. Atomic excitation and ionization accompanying orbital electron capture by nuclei. H. Primakoff and F. T. Porter. *Phys. Rev.*, **89**, 930–7 (*March* 1, 1953).

The process of atomic excitation and ionization accompanying orbital electron capture by nuclei is

treated on the basis of the general theory of β-decay using a configuration space representation for both nucleons and leptons. Quantitative expressions are obtained (*a*) for the total number of double holes produced in the *K*-shell due to *K*-capture accompanied by excitation or ejection of the other *K*-electron, and (*b*) for the total probability of electron ejection in orbital electron capture together with the ejected electron momentum spectrum. A discussion is given of the possibilities of experimental verification of the theory developed. A.

539.165.8

3560. Correlation between electron and recoil nucleus in He^6 decay. B. M. Rustad and S. L. Ruby. Letter in *Phys. Rev.*, **89**, 880 (*Feb.* 15, 1953).

The study of coincidence rate as a function of the angle between the two particles in a given interval of energies, or as a function of energy at a given angle, indicates that the tensor interaction is much more important than the axial vector one (the remaining interactions are forbidden for this particular transition). L. PINCHERLE

539.166

3561. 11-MeV thick target bremsstrahlung. J. W. Motz, W. Miller and H. O. Wyckoff. *Phys. Rev.*, **89**, 968–71 (*March* 1, 1953).

The intensity distribution of the photons in the forward direction from the 60-mil W wire target of the U.S. Naval Ordnance Laboratory 11-MeV betatron was determined in an energy range of 0·3 to 12 MeV from measurements made with a magnetic Compton spectrometer. The experimental results showed good agreement with the Bethe–Heitler bremsstrahlung theory after corrections were made for target thickness effects and the absorption produced by materials in the path of the photon beam. The photon energy flux density for the measured spectrum was converted to an equivalent roentgen rate value, which agreed within 10% with the value obtained from measurements made with a Victoreen thimble chamber. A.

539.166

3562. The gamma-rays from negative μ-meson capture in lead. G. G. Harris and T. J. B. Shanley. *Phys. Rev.*, **89**, 983–90 (*March* 1, 1953).

The γ-rays produced when a negative μ-meson stops in lead have been studied by means of a cloud chamber in a magnetic field. The presence of these γ-rays is confirmed. It is concluded that both nuclear γ-rays and Bohr orbit γ-rays are necessary to explain the experimental data. A.

539.166

3563. Direction and polarization correlations of successive gamma-rays. J. J. Kraushaar and M. Goldhaber. *Phys. Rev.*, **89**, 1081–9 (*March* 1, 1953).

Experimental arrangements for the measurement of directional and direction-polarization correlations of successive γ-rays have been set up and considerations given to instrumental corrections and procedures for the analysis of the data. Directional measurements have been made with Co^{60}, Rh^{106}, Sb^{124}, As^{76} and Ir^{194}, and direction-polarization measurements with Co^{60}, Rh^{156} and ThC″. The results are discussed in the light of present information on the systematics of the spins of the excited states of even-even nuclei. The occurrence of mixtures of magnetic dipole and electric quadrupole radiation in directional correlation experiments is summarized. A.

539.166.1

3564. A precision measurement of the ^{137}Cs γ-line. G. Lindström, K. Siegbahn and A. H. Wapstra. *Proc. Phys. Soc.* [*London*] *B*, **66**, 54–9 (*Jan.*, 1953).

The recent establishment of a set of standard lines for precision work in β-ray spectroscopy is reviewed. In this work use was made of a semicircular spectrometer adjusted for high resolution, the proton resonance method for measuring the magnetic field and a large double focusing spectrometer. In this way absolute measurements of the lines were made, as well as a number of different relative measurements. The general consistency is very satisfactory, indicating a precision of the standard lines of 1 or 2 parts in 10^4. So far the following lines have been measured: the *F*, *I*, *L* and *X* lines of Th(B, C′), the 411 keV line of Au^{198}, the annihilation radiation, the 2·75 MeV line of Na^{24}, the 662 keV line of Cs^{137}. In the present paper the measurements of the Cs^{137} are described. The line has been studied as a conversion line and as a photo line emanating from a uranium convertor. The combined results of the two spectrometers yield the following value of the energy of the Cs^{137} line: $E_\gamma = 661{\cdot}65 \pm 0{\cdot}15$ keV. The $H\rho$ value of the conversion line is $3381{\cdot}28 \pm 0{\cdot}50$ gauss cm. A.

539.166.74

3565. Multiple Compton scattering of low energy gamma-radiation. R. C. O'Rourke. *Phys. Rev.*, **89**, 999–1003 (*March* 1, 1953).

The exact problem of multiple Compton scattering in an infinite plane parallel medium is set up for a monochromatic primary spectral distribution normally incident upon a semi-infinite medium for isotropic scattering. It is treated by a different approach to that previously used by the author [Abstr. 3839 (1952)], the new approach being based in part on Marshak's method of spherical harmonics. Numerical results are presented for the P_1 approximation to this problem. This result is compared with the corresponding solution obtained previously. The present method shows that the broadening is not as severe as the previous method had indicated. A.

539.166.83

3566. The internal conversion of magnetic dipole radiation in the L_1-shell with consideration of the finite dimensions of the nucleus. L. A. Sliv and M. A. Listengarten. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 29–33 (1952) *In Russian.*

The conversion coefficients β_K, β_{L1} for *K* and L_1 shells were calculated using screened relativistic wave functions and a finite nucleus represented by a surface distribution of charges and currents. The results (insensitive to the last assumption) are plotted for $Z = 83$ and $mc^2/\hbar\omega$ from 0·3 to 3·0. In this range β (zero radius)/β (finite radius) $\sim 1{\cdot}5$. The largeness of $\beta_K/\beta_{L1} \sim 8{\cdot}5$ affords a method of distinguishing magnetic dipole from electric quadrupole radiation. An application to the conversion of the 241, 294, 350 keV lines of RaB $\rightarrow$ RaC leads to consistent results indicating a mixture of both types of radiation,

the fraction of the latter decreasing with increasing γ energy. W. J. SWIATECKI

539.166.83 : 539.18

3567. On the electrons produced in the capture of μ-mesons into atomic levels. B. L. IOFFE AND I. YA. POMERANCHUK. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 1(7) 123–4 (1952) *In Russian.*

The number of Auger electrons associated with the mesonic transitions $2s_{\frac{1}{2}} \rightarrow 2p_{\frac{1}{2}}$ and $2s \rightarrow 1s$ are estimated $(3\times10^{11}\ \text{sec}^{-1}$ and $2{\cdot}4\times10^{9}\ \text{sec}^{-1}$ resp. for $Z = 6$). W. J. SWIATECKI

539.166.835

3568. Relative pair production cross section at low energies. G. M. GRIFFITHS AND J. B. WARREN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 1050–2 (*Dec.*, 1952).

Using a three-crystal (scintillation) pair spectrometer together with Na^{24} and Co^{60} γ-ray sources, the following cross-section ratios were obtained: $P_{2\cdot76}/P_{1\cdot38} = 14{\cdot}5 \pm 2{\cdot}5$; $P_{1\cdot33}/P_{1\cdot17} = 5{\cdot}2 \pm 1{\cdot}5$. These compare with Born approximation estimates of 18·5 and 6·4 respectively, the discrepancies being in the expected direction. J. J. WILKINS

539.166.835

3569. Pair creation in intermediate coupling theory. R. G. MOORHOUSE. *Phys. Rev.*, **89**, 958–65 (*March* 1, 1953).

The approximations of the intermediate coupling method are applied to a model of the self-field of a single nucleon (interacting with a pseudoscalar meson field) in which only processes involving pair creation and annihilation are allowed. In order to do this a method of subtracting the vacuum before these approximations are made, is suggested. The magnetic moment of the self-field on this model is investigated, and a comparison is made with the antithetic model of the self-field in which only processes not involving pair creation or annihilation are allowed. A.

539.166.835

3570. Momentum transfer and angle of divergence of pairs produced by photons. A. BORSELLINO. *Phys. Rev.*, **89**, 1023–5 (*March* 1, 1953).

The distribution of the momentum transferred to the pairs in pair production by photons has been derived from the Bethe–Heitler cross-section. The effect of screening is evaluated using a shielded Coulomb potential for the nucleus. In the last part of the article the distribution of the angle of divergence of the pair is obtained, and the most probable angle of divergence is given by $\phi(E_+/k)\cdot 4mc^2/k$, where k and E_+ are the energies of the photon and the positron and $\phi(E_+/k) \sim 1$ for $0{\cdot}2 < E_+/k < 0{\cdot}5$. A.

539.166.9

3571. The influence of the spectrum of γ-radiation on the transition effect of γ-rays. I. V. ÉSTULIN. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 85–91 (1952) *In Russian.*

A compensating arrangement of 2 flat ionization chambers whose front walls consisted each of an Al foil, an Al plate and the same number of Pb foils were exposed to 0·1–2·62 MeV γ's from Ra or RaTh sources and the difference of the currents measured as function of the number of Pb foils inserted between the Al foil and plate of one of the chambers. Associated with the transition of the γ's from an element with low Z to one with high Z there is at first a rapid rise of the current followed by a fall when the inserted Pb foils exceed $\sim 0{\cdot}1\ \text{g cm}^{-2}$. The influence of Pb shields over the γ sources and of the nature of the rear wall were investigated. W. J. SWIATECKI

539.167.3

3572. Assignment of mass-number 188 to the 18-min nuclear isomer of Re by chemical means. W. HERR. Note in *Z. Naturforsch.*, **7a**, 819–20 (*Dec.*, 1952) *In German.*

The decay product of the 18-min nuclear isomer of (4-valent) Re appears as Re-VII in the form ReO_4^- (due to a rearrangement of the orbital electrons; cf. Szilard–Chalmers separation). K_2ReCl_6 was irradiated with slow neutrons, and any Re-VII formed during irradiation reconverted to Re-IV. Inactive Re-VII was added as carrier, and after the complete decay of the 18-min isomer, a separation of Re-IV and Re-VII was effected. The Re-VII fraction decayed with a $\frac{1}{2}$-life of 17 hr (Re^{188}), showing that the 18-min activity is an isomer of Re^{188}. A. O. STANESBY

539.167.3

3573. Contribution to the study of methods of separation and identification of nuclear isomers. G. KAYAS. *Ann. Phys.* [*Paris*] **7**, 802–51 (*Nov.–Dec.*, 1952) *In French.*

Pt I: Review of the subject of isomerism, especially chemical changes induced by nuclear processes (Szilard–Chalmers). Pt II: Using positive and negative ion exchange columns and G.M. counters, the isomerism of Br^{80} was studied. A considerable fraction (~75%) of Br^{80} in the ground state could be separated, showing that the isomeric transition changes the chemical character of the atom. The importance for this of internal conversion is confirmed by the negative results of attempted separation of isomers of Zn^{69} where the conversion is known to be weak. W. J. SWIATECKI

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 3405, 3418

539.172

3574. Excitation cross section for helium atoms. II. S. ALTSHULER. *Phys. Rev.*, **89**, 1093–5 (*March* 1, 1953).

For Pt I, see Abstr. 8403 (1952). The excitation scattering of electrons from He atoms is investigated for the case of transition to the first excited singlet metastable level in order to examine quantitatively the error introduced by the fact that the description of the He target is only approximately known. The cross-section is calculated in Born approximation using formally equivalent matrix elements which weight the wave functions differently in space. The shape of the total cross-section energy curve is the same although absolute values differ while the angular distributions are considerably different. A.

539.172.1

3575. Activities in light nuclei from nitrogen ion bombardment. L. D. WYLY AND A. ZUCKER. Letter in *Phys. Rev.*, **89**, 524 (*Jan.* 15, 1953).

N_{14}^{+++} ions, accelerated to ~25 MeV, were used to bombard D, Be, C and O targets, and the disintegration products formed identified from the periods of the induced activity. Of the reactions energetically possible, the most exo-energetic were favoured, and in some cases fusion of a substantial portion of both nuclei occurred. J. HUGHES

539.172.13

3576. Angular correlations in the reaction $^{15}N(p, \alpha\gamma)^{12}C$. J. SEED AND A. P. FRENCH. Letter in *Phil. Mag.*, **43**, 1214–16 (*Nov.*, 1952).

(α, γ) correlations were studied in planes containing and perpendicular to the incident proton direction, and in each plane showed a high degree of anisotropy. The results are consistent with an orbital momentum of 2 for the incoming protons, and spin 2 and odd parity for the compound nucleus O^{16*}. A. O. STANESBY

539.172.13

3577. The radiative capture of protons in fluorine. G. A. JONES AND D. H. WILKINSON. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 1055 (*Dec.*, 1952).

A thick target of CaF_2 was bombarded with 700 keV protons. The low energy γ produced in the cascade was measured as $1{\cdot}66 \pm 0{\cdot}02$ MeV. The coincidence rate agreed well with that expected. F. R. HOLT

539.172.13

3578. Electron capture. II. Resonance capture from hydrogen atoms by slow protons. A. DALGARNO AND H. N. YADAV. *Proc. Phys. Soc.* [*London*] *A*, **66**, 173–7 (*Feb.*, 1953).

For Pt I, see Abstr. 1904 (1953). The cross-sections for resonance electron capture from H atoms by protons of incident energy up to 100 keV are calculated theoretically using the Perturbed Stationary State method, and a comparison is made with the results of the Born approximation both with and without neglect of momentum transfer. A.

539.172.13

3579. Nuclear stars in emulsions. R. W. WANIEK AND T. OHTSUKA. Letter in *Phys. Rev.*, **89**, 882 (*Feb.* 15, 1953).

Plates were exposed at 0° and 14° to neutrons from Be bombarded by 95 MeV protons. Differences in the statistics of stars in the two plates are attributable to the difference between the two n spectra, which corresponds to a peak of neutrons of 80 to 105 MeV. W. J. SWIATECKI

539.172.13

3580. Production of polarized particles in nuclear reactions. A. SIMON AND T. A. WELTON. Letter in *Phys. Rev.*, **89**, 886 (*Feb.* 15, 1953).

The general conditions required for production are discussed. It is possible that polarized neutrons are emitted in several resonant (p, n) reactions. J. M. CASSELS

539.172.13

3581. On the angular distribution of D + D nuclear reaction products. Y. NAKANO. *Progr. theor. Phys.*, **8**, 39–48 (*July*, 1952).

The anisotropy coefficients of the angular distribution of $D + D \rightarrow H + T$ reaction products, $I(\theta) = A(1 + B\cos^2\theta + C\cos^4\theta)$, are reproduced theoretically by the W.K.B. method, taking incident D-wave and spin-orbit coupling into account, on the lines of Konopinski and Teller (1948) in the higher energy range up to 3·5 MeV. A.

539.172.13

3582. The cross-section and angular distribution of the D-D reactions below 50 keV. E. A. ELIOT, D. ROAF AND P. F. D. SHAW. *Proc. Roy. Soc. A*, **216**, 57–65 (*Jan.* 7, 1953).

A thin gas target was used and the particles from the reactions were detected by a proportional counter. The results show that the total cross-section for the two reactions is the same to within 1%, but that the angular distributions of the products are significantly different. The asymmetry coefficient for the reaction $D(d, n)\,He^3$ is given by $0{\cdot}31 + 0{\cdot}0058E$, compared with $0{\cdot}13 + 0{\cdot}0047E$ for reaction $D(d, p)H^3$, where E is the bombarding energy in kilovolts. A.

539.172.13

3583. Angular dependence and yield of the $Be^9(d, p)Be^{10}$ and $Be^9(d, t)Be^8$ reactions. D. DE JONG, P. M. ENDT AND L. J. G. SIMONS. *Physica*, **18**, 676–82 (*Oct.*, 1952).

Differential cross-sections have been measured of the $Be^9(d, p)Be^{10}$ and $Be^9(d, t)Be^8$ ground-state transitions at five deuteron energies between 0·30 MeV and 0·62 MeV. The proton angular distributions can be developed into series of Legendre polynomials of which the highest term is a_4P_4 while the developments of the triton distributions above $E_d = 0{\cdot}45$ MeV need also the terms a_5P_5 and a_6P_6. The total cross-sections of the two reactions are equal within the experimental error below $E_d = 0{\cdot}45$ MeV while above this energy the $Be^9(d, p)Be^{10}$ reaction predominates. A.

539.172.13

3584. Observations on neutron-deficient rhodium isotopes. A. H. W. ATEN, JR, H. CERFONTAIN, W. DZCUBAS AND T. HAMERLING. Letter in *Physica*, **18**, 972–3 (*Nov.*, 1952).

A positron-emitting Rh isotope with a ½-life of 9 mm was obtained by irradiating Ru with 28 MeV deuterons. A. O. STANESBY

539.172.13

3585. Some features of the deuteron stripping process. R. H. DALITZ. *Proc. Phys. Soc.* [*London*] *A*, **66**, 28–32 (*Jan.*, 1953).

The stripping model of Butler is presented in a simpler, more intuitive form which is used to show that the outgoing nucleons are unpolarized, and to calculate the statistical matrix of the final nucleus, from which the angular distribution of later radiation may be calculated by the method of Spiers. A.

539.172.13

3586. An investigation of the neutron groups from the reactions $^{12}C(d, n)^{13}N$, $^{16}O(d, n)^{17}F$ and $^{32}S(d, n)^{33}Cl$. R. MIDDLETON, F. A. EL-BEDEWI AND C. T. TAI. *Proc. Phys. Soc.* [*London*] *A*, **66**, 95–107 (*Jan.*, 1953).

The experimental arrangement and method of

investigation by the photographic plate technique of (d, n) reactions at a deuteron bombarding energy of 3 MeV are described. The positions are reported of some of the energy levels of the residual nuclei N^{13}, F^{17} and Cl^{33}. It has also been possible to determine spins and parities of the corresponding levels from measurements of the angular distributions of some of the neutron groups. A comparison of the mirror nuclei $C^{13}N^{13}$, $O^{17}F^{17}$ and $S^{33}Cl^{33}$ is made. A.

539.172.13

3587. An investigation of the reaction $^{14}N(d, n)^{15}O$ at 8 MeV deuteron energy. W. H. Evans, T. S. Green and R. Middleton. *Proc. Phys. Soc.* [*London*] *A*, **66**, 108–14 (*Jan.*, 1953).

The neutrons emitted from a nitrogen gas target bombarded by 7·7 MeV deuterons have been investigated using the photographic plate technique. The existence of six excited states of O^{15} has been established and certain predictions about the spins and parities of these levels have been made by comparing the observed angular distributions of the corresponding neutron groups with those based on a nuclear stripping theory. A.

539.172.13

3588. The D-D cross-section and angular distribution between 55 and 430 keV. P. A. Davenport, T. O. Jeffries, M. E. Owen, F. V. Price and D. Roaf. *Proc. Roy. Soc. A*, **216**, 66–71 (*Jan.* 7, 1953).

The cross-section and angular distributions of protons from the D-D reaction using thin gas targets have been measured from 55 to 430 keV. The results have been expressed in the form $\sigma_\theta = \sigma/[4\pi(1 + \frac{1}{3}A + \frac{1}{5}B)](1 + A\cos^2\theta + B\cos^4\theta)$. The variation of the total cross-section σ and the asymmetry coefficients A and B over the energy range 15 to 190 keV can be described by the theory of Beiduk, Pruett and Konopinski introducing only a small or negligible amount of spin-orbit coupling. The ratio of the number of He^3's to H^3's has been measured up to 250 keV at a few angles in the forward direction only, and found to be unity within experimental error. See also Abstr. 4600 (1952). A.

539.172.13 : 537.534.74

3589. A precise technique for the determination of some nuclear reaction energies. E. R. Collins, C. D. McKenzie and C. A. Ramm. *Proc. Roy. Soc. A*, **216**, 219–41 (*Jan.* 22, 1953).

A technique has been developed for the absolute determination of nuclear reaction energies by means of a 180° magnetic spectrometer, in which the effective diameter has been measured against a standard scale, and the magnetic field determined by means of a nuclear resonance apparatus. These two measurements, together with the angle of reaction, were the only precise dimensions required. The spectrometer was used to establish a high-voltage scale by means of elastic scattering of protons. Thus sufficient data could be obtained in a nuclear reaction to determine the Q values which are presented in a separate paper (see abstract following). In order to utilize the experimental data efficiently, it was necessary to investigate quantitatively the line shapes in the spectrometer. An empirical method for correcting observed reaction energies for target deterioration is discussed. To obtain verification of the theoretical line shapes for nearly monoenergetic sources, the $H\rho$ values for several groups of natural α-particles have been measured and the following results obtained, in kilogauss cm: ThC', 427·07 ± 0·10; Th$C\alpha_0$, 354·34; Th$C\alpha_1$, 355·51; Po, 331·76 ± 0·09. A.

539.172.13 : 537.534.74

3590. Energy values for some proton and deuteron reactions with ^{6}Li, ^{7}Li, ^{9}Be, ^{11}B and ^{15}N. E. R. Collins, C. D. McKenzie and C. A. Ramm. *Proc. Roy. Soc. A*, **216**, 242–6 (*Jan.* 22, 1953).

See preceding abstract. The following values of nuclear reaction energies have been obtained: $Li^6(p, \alpha)He^3$, $Q = 4{\cdot}023$ MeV; $Li^6(d, p)Li^7$, $Q = 5{\cdot}028$ MeV; $Li^6(d, p)Li^{7*}$, $Q = 4{\cdot}553$ MeV; $Li^6(d, \alpha)\alpha$, $Q = 22{\cdot}396$ MeV; $Li^7(p, \alpha)\alpha$, $Q = 17{\cdot}352$ MeV; $Be^9(p, \alpha)Li^6$, $Q = 2{\cdot}126$ MeV; $Be^9(p, d)Be^8$, $Q = 0{\cdot}560$ MeV; $Be^9(d, \alpha)Li^7$, $Q = 7{\cdot}153$ MeV; $Be^9(d, \alpha)Li^{7*}$, $Q = 6{\cdot}675$ MeV; $B^{11}(p, \alpha)Be^8$, $Q = 8{\cdot}589$ MeV; $N^{15}(p, \alpha)C^{12}$, $Q = 4{\cdot}962$ MeV. The average value of the first excited level in Li^7 has been found to be 0·477 ± 0·003 MeV from the difference between the ground state and first excited state groups of the $Li^6(d, p)Li^7$ and $Be^9(d, \alpha)Li^7$ experiments. A.

539.172.13

3591. States of S^{33} and Si^{29} from (d, p) stripping. J. R. Holt and T. N. Marsham. Letter in *Phys. Rev.*, **89**, 665 (*Feb.* 1, 1953).

Tables of the excitation energies, the relative neutron capture probability and the orbital angular momenta of the captured neutrons are given, for the states produced by the reactions $S^{32}(d, p)S^{33}$ and $Si^{28}(d, p)Si^{29}$ with 8 MeV incident deuterons. From these results level spin assignments are discussed using the nuclear shell model. J. Hughes

539.172.13

3592. An investigation of (d, p) stripping reactions. I. Apparatus and results for aluminium. J. R. Holt and T. N. Marsham. *Proc. Phys. Soc.* [*London*] *A*, 249–57 (*March*, 1953).

An apparatus is described which enables angular distribution measurements to be carried out within the angular region −5° to +140° on disintegration particles of long range. The differential range spectrum is measured at each angle by the use of a triple proportional counter of novel design. Measurements are reported for the two proton groups of longest range produced in the reaction $Al^{27}(d, p)Al^{28}$ with a deuteron energy of 8 MeV and the results discussed in the light of the theories of the stripping process. A.

539.172.13

3593. An investigation of (d, p) stripping reactions. II. Results for the isotopes of magnesium. J. R. Holt and T. N. Marsham. *Proc. Phys. Soc.* [*London*] *A*, **66**, 258–67 (*March*, 1953).

Angular distribution measurements have been carried out on a number of proton groups from the bombardment with 8 MeV deuterons of targets of natural magnesium and of $Mg^{25}O$ and $Mg^{26}O$. Spins and parities have been assigned to various states of the product nuclei on the basis of the theory of the stripping process. These are given herewith, the excitation energy of each state in MeV being followed by the possible spin values and the parity in brackets:

Mg^{25}: ground state (5/2, 3/2 +), 0·582(1/2 +), 0·976(5/2, 3/2 +), 1·957(5/2, 3/2 +), 3·405(3/2, 1/2 −). Mg^{26}: 1·825(3, 2 + and 5, 4 . . . 0 +), 2·972(3, 2 +), 3·969(3, 2 +), 4·353(3, 2 +), 6·147(3, 2 +). Mg^{27}: ground state (1/2 +), 0·887(5/2, 3/2 +), 3·50(1/2 +). The following new energy levels have been observed: Mg^{25}: 4·62 ± 0·05, 5·05 ± 0·08, 5·49 ± 0·05 and 6·40 ± 0·05 MeV. Mg^{26}: 7·29 ± 0·06 and 8·28 ± 0·06 MeV. Mg^{27}: 3·50 ± 0·05 MeV. A.

539.172.13

3594. The angular correlation of the protons and γ-radiation from the reaction $^6Li(d, p)^7Li^*\gamma^7Li$. A. J. Salmon and E. K. Inall. *Proc. Phys. Soc.* [*London*] *A*, **66**, 297–303 (*March*, 1953).

In order to provide information on the first excited state of Li^7 the angular correlation between the protons and the γ-radiation from the reaction $Li^6(d, p)Li^{7*}\gamma Li^7$ has been studied. An isotropic angular correlation was observed. The angular correlations, predicted theoretically, for the most likely transitions in this reaction have been determined. It is shown that an isotropic angular correlation indicates that, very probably, $J = \frac{1}{2}$ for this state. A.

539.172.13

3595. Angular distribution of protons from vanadium 52. J. S. King and W. C. Parkinson. *Phys. Rev.*, **85**, 1080 (*March* 1, 1953).

Angular distributions have been obtained for the protons from the ground and first excited states for the reaction $V^{51}(d, p)V^{52}$. The results indicate that the captured neutron carries in mainly one unit of orbital angular momentum for both states. The 29th neutron is thus presumed to be a $p_{\frac{3}{2}}$ nucleon. A.

539.172.3

3596. Some remarks on the photo-disintegration of deuteron. I. Y. Nagahara and J. Fujimura. *Progr. theor. Phys.*, **8**, 49–52 (*July*, 1952).

The photodisintegration process of the deuteron is investigated by extrapolating from the low-energy side, and the contribution of mesons is also discussed. The singularity of exchange magnetic moments gives some possibility of explaining the experiments. A.

539.172.3

3597. The forbidden nature of the reaction $^6Li(\gamma, d)^4He$ for γ-rays of energies up to 17·6 MeV. E. W. Titterton and T. A. Brinkley. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 1052–3 (*Dec.*, 1952).

The following upper limits for the reaction cross-section are reported: $(8 \pm 2) \times 10^{-30}$ cm² at 2·76 MeV; $(6 \pm 3) \times 10^{-30}$ cm² for $F^{19}(p, \gamma)$ radiation; $(5 \pm 2) \times 10^{-39}$ cm² for $Li^7(p, \gamma)$ radiation. The difficulties involved in explaining these results are discussed.

J. J. WILKINS

539.172.3

3598. Photofission and photoneutron emission in uranium. R. B. Duffield and J. R. Huizenga. *Phys. Rev.*, **89**, 1042–6 (*March* 1, 1953).

The yields of the two reactions $U^{238}(\gamma, n)U^{237}$ and $U^{238}(\gamma,$ fission) produced by bremsstrahlung have been measured as a function of the maximum energy of the X-ray spectrum. The ratio of the number of fissions to the number of U^{237} atoms produced decreased from 0·390 at 8 MeV to 0·275 at 12 MeV and then increased to 0·465 at 22 MeV. These data are interpreted to show that for maximum X-ray energies in excess of 12 MeV, a fraction of the U^{237} atoms formed by the (γ, n) reaction are left with sufficient excitation energy for fission or secondary neutron emission to occur. The cross-sections for the reactions as a function of γ-ray energy have been calculated from the yield data. A.

539.172.4

3599. The temperature dependence of the scattering cross-section of bound protons for slow neutrons. W. Guber. *Z. Naturforsch.*, **7a**, 725–8 (*Nov.*, 1952) *In German.*

Cross-sections for H_2 gas between −55 and +208°c determined by absorption measurements using a BF_3 counter agree with the theory of Messiah (1951). W. J. SWIATECKI

539.172.4

3600. Neutron detection with boron trimethyl and investigation of the $B^{10}(n, \alpha)Li^7$ reaction. U. H. Hauser. *Z. Naturforsch.*, **7a**, 781–5 (*Dec.*, 1952) *In German.*

This gas is very suitable for filling slow neutron proportional counters. It is more stable than BF_3, has a long life, and may be used at pressures up to about 4 atmospheres. The reaction was investigated using a mixture with argon. Results were: $Q' = 2{\cdot}304 \pm 0{\cdot}025$ and $Q = 2{\cdot}781 \pm 0{\cdot}025$ MeV. The probability of transition to the Li^7 ground state was 5·8 ± 0·1%. F. R. HOLT

539.172.4

3601. Measurement of nuclear rays [neutron cross-sections] of sulphur and copper. M. Ageno, G. Cortellessa and R. Querzoli. *R.C. Ist. Super. Sanità*, **15**, *Pt VIII*, 555–76 (1952).

A procedure is described for measuring the total cross-sections of elements for neutrons of 13·3 MeV, with a satisfactory correction of the transmission data for scattered slow neutrons. The experimental conditions are such as to reduce to a minimum the correction for non-ideal geometry. The total cross-section of Cu was measured to be: $(3{\cdot}09 \pm 0{\cdot}12) \times 10^{-24}$ cm², in agreement, within the limits of experimental error, with previous measurement. The total cross-section of S was measured, which, according to other authors, differs considerably from the average behaviour as a function of the mass number, and the value was found: $(2{\cdot}06 \pm 0{\cdot}07) \times 10^{-24}$ cm², in complete agreement with this behaviour. The conclusion is that the anomalies indicated by others in the total cross-section of S are caused by errors of measurement. The values of efficacious and effective nuclear radii of Cu and S are deduced, according to the Weisskopf theory. A.

539.172.4

3602. Radiative capture of a fast neutron in hydrogen. A. M. Korolev. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7) 3–7 (1952) *In Russian.*

The cross-section σ (capture) is calculated using a phenomenological short-range *n–p* potential and non-relativistic perturbation theory, and compared with σ (scattering). At ∼340 MeV σ (cap.) $\sim 10^{-29}$ cm². W. J. SWIATECKI

539.172.4

3603. Production of Fe^{59} by the $Co^{59}(n, p)$ reaction in the Brookhaven reactor. A. C. WAHL. Letter in *J. chem. Phys.*, **21**, 182 (*Jan.*, 1953).

The chemical techniques used are described. The production, carrier-free, is comparable economically with cyclotron production. F. R. HOLT

539.172.4

3604. The thermal neutron absorption cross section of scandium. E. E. LOCKETT AND E. BOWELL. Letter in *Phys. Rev.*, **89**, 657 (*Feb.* 1, 1953).

This, for pile neutrons, was measured as $23(+1, -3)$ barns. The discrepancies with other published values are accounted for. F. R. HOLT

539.172.4

3605. Isomeric branching and threshold behavior of the reaction $Mo^{92}(n, 2n)Mo^{91}$. J. E. BROLLEY, JR. Letter in *Phys. Rev.*, **89**, 877 (*Feb.* 15, 1953).

A curve based on the statistical theory can be fitted to the experimental excitation function for the production of 15·5 min Mo^{91}. The threshold so found does not agree with the results of betatron work on the corresponding (γ, n) reaction. The $(n, 2n)$ reaction produces very little 65·5 sec Mo^{91}. J. M. CASSELS

539.172.4

3606. The elastic scattering of neutrons by tritons at 14 MeV. P. SWAN. *Proc. Phys. Soc.* [*London*] *A*, **66**, 238–48 (*March*, 1953).

The theory of neutron-triton scattering has been worked out, using Wheeler's resonating group structure method, and applied to a neutron energy of 14 MeV for four types of nuclear interaction: an ordinary force, an exchange force of Majorana–Heisenberg type, a symmetrical exchange force, and the Serber exchange mixture. The nuclear potential is taken in the Gaussian form $V_0 \exp(-\mu r^2)$ and the corresponding two body ground state wave function as $N_0 \exp(-\frac{1}{2}\lambda r^2)$. The resulting integro-differential equations for scattering are solved by variational methods. The symmetric and Majorana–Heisenberg forces give the right general shape for the angular distribution of scattering, but the ordinary and Serber forces give a rather higher peak of back scattering than indicated by the experiments of Coon, Bockelman and Barschall at 14 MeV. The measurements appear to favour forces of a symmetrical exchange type as against an ordinary force type. A.

539.172.4

3607. The asymmetry of fission and the liquid drop model. P. DEMERS. *C.R. Acad. Sci.* [*Paris*] **235**, 1637–9 (*Dec.* 22, 1952) *In French.*

When two soap bubbles are connected, one grows at the expense of the other as a result of surface tension. It is suggested that in nuclear fission an analogous effect occurs at the moment of separation. J. M. CASSELS

539.172.4

3608. Fission yields of the stable and long-lived isotopes of cesium, rubidium, and strontium and nuclear shell structure. D. R. WILES, B. W. SMITH, R. HORSLEY AND H. G. THODE. *Canad. J. Phys.*, **31**, 419–31 (*March*, 1953).

The relative yields of the isotopes of Cs, Rb and Sr from thermal neutron fission of U^{235} have been determined mass spectrometrically. The Cs isotope yields are combined with those obtained previously for the xenon isotopes to give high precision yields for mass chains from 131 to 137. In this work neutron capture reactions have been considered and corrections made where these take place to an appreciable extent. The results give further evidence of abnormal yields in the 82 neutron shell region. The half-life of Cs^{137} was determined and found to be 33 ± 2 yr. A.

539.172.4

3609. Elementary theory of neutron sources in reactors. A. V. MASKET. *Amer. J. Phys.*, **21**, 151–9 (*March*, 1953).

The basic physical and mathematical ideas involved in the use of a neutron source in reactors in the steady state are developed from the diffusion theory of neutrons of one energy group. The ideas are fundamental to more general and difficult discussions in published material and should serve as a helpful preliminary to the formal study of reactor theory. A.

539.172.4

3610. An enhanced reactor. F. E. O'MEARA. *Phys. Rev.*, **89**, 982 (*March* 1, 1953).

The possibility of using a thermal U reactor to induce secondary fusion reactions is examined. Deuterons and tritons are accelerated by collisions with neutrons and fission fragments and the resulting *D–T* reactions are calculated to yield 10^{-3} neutron per fission. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3611. On the mean life of the V_1^0 particle. B. D'ESPAGNAT. *C.R. Acad. Sci.* [*Paris*] **235**, 1610–12 (*Dec.* 22, 1952) *In French.*

It is possible to explain the lives of V_1^0 and π using a single coupling constant provided that it is ps. vector and not ps. scalar. W. J. SWIATECKI

539.18

3612. The production of γ-quanta and neutral mesons in the capture of π^--mesons by deuterons. I. B. L. IOFFE, A. P. RUDIK AND I. M. SHMUSHKEVICH. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 11–20 (1952) *In Russian.*

Detailed derivation by non-relativistic perturbation theory of differential and total cross-sections for the radiative capture of a π^- by a deuteron assuming scalar or ps. scalar π^- with either kind of coupling. Quanta with energies near the maximum possible are most probable. The total capture cross-section differs in all cases by the factor

$$\{1 - [(4M\varepsilon_0)^{\frac{1}{2}}/\mu c] \tan^{-1} [\mu c/(4M\varepsilon_0)^{\frac{1}{2}}]\}$$

from the corresponding values for capture by a proton [Abstr. 510 (1950)]. (M, μ = nucleon, meson mass and ε_0 = deuteron binding energy). W. J. SWIATECKI

539.18

3613. The production of γ-quanta and neutral mesons in the capture of π^--mesons by deuterons. II. B. L. Ioffe, A. P. Rudik and I. M. Shmushkevich. *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 21–8 (1952) *In Russian.*

Derivation by non-relativistic perturbation theory of differential and total cross-sections for the capture of a π^- with the emission of a π^0 when both mesons have spin 0 and for the 4 possible combinations of their parities and all possible types of coupling. The corresponding results for the capture of a π^- by a proton and for radiative capture (preceding abstract) are listed and discussed in view of experimental cross-sections. Agreement can be obtained only if both π^- and π^0 are ps. scalar. W. J. SWIATECKI

539.18

3614. Creation of π^+-mesons in the collision of protons. R. Paruntseva. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 123–4 (1952) *In Russian.*

The cross-section for this is calculated by perturbation theory when the final state is (*a*) a deuteron, (*b*) 2 free nucleons. A ps. scalar π with ps. vector coupling is assumed. $\sigma_a \sim 3{\cdot}6\times10^{-28}$ cm^2, $\sigma_b \sim 1{\cdot}2\times10^{-28}$ cm^2. The spectrum of the mesons shows the characteristic peak at its upper limit.

W. J. SWIATECKI

539.18

3615. Note on the production of pseudoscalar mesons. J. McConnell. *Proc. Roy. Irish Acad. A*, **55**, *No.* 6, 101–8 (*Jan.*, 1953).

A re-examination of the calculations of Heitler and Peng (1943) and Heitler (1945) lead to a sensitive dependence of the production cross-section σ on the minimum value of the impact parameter. At energies $E \sim 1000$ BeV the production of π's alone would not suffice to account for the observed constancy of σ with E. W. J. SWIATECKI

539.18

3616. Probable emission of a nuclear fragment containing a V^0 particle. J. Crussard and D. Morellet. *C.R. Acad. Sci.* [*Paris*] **236**, 64–6 (*Jan.* 5, 1953) *In French.*

A star with 60 prongs of which 1 produces a small secondary star with 4 prongs of which 1 is a π-meson track can be interpreted as the emission of an "α" or "Li" fragment in which a neutron is replaced by a V^0 and whose subsequent decay produces the 2nd star. W. J. SWIATECKI

539.18

3617. Multiple meson production. L. S. Kothari. Letter in *Nature* [*London*] **171**, 309 (*Feb.* 14, 1953).

The number of π and κ mesons ($m_\kappa = 1300\, m_e$) created in a nucleon collision is calculated on Fermi's theory. The ratio n_κ/n_π decreases from $\sim 1/17$ at $3{\cdot}5$ Mc^2 (lab. system) to $\sim 1/39$ at $16{\cdot}9$ Mc^2.

W. J. SWIATECKI

539.18

3618. Damping corrections in the photo-meson process. G. R. Allcock. *Proc. Phys. Soc.* [*London*] *A*, **66**, 233–7 (*March*, 1953).

An examination is made of the effect of damping on the photo-production of pseudoscalar charged and neutral π-mesons from protons, ignoring all self-energy effects. In the case of pseudoscalar coupling the damping corrections are large, but do not greatly remedy the disagreement of second-order perturbation theory with experiment; while for pseudovector coupling damping effects are unimportant. A.

539.18

3619. The capture process of π mesons by deuterons. Y. Matsuzaki and M. Sasaki. *Progr. theor. Phys.*, **7**, 573–7 (*May–June*, 1952).

Capture processes of positive π-mesons by deuterons are theoretically treated under the assumption that mesons are of pseudoscalar type and have pseudovector coupling. The forces in the final triplet P-state of the p–p system have also been considered and their influence on the final results investigated. The calculation shows that if one assumes strong repulsion in P-state, better agreement with experiments is to be obtained. A.

539.18

3620. Atomic number dependence of neutral meson yield from proton bombardment. R. W. Hales and B. J. Moyer. *Phys. Rev.*, **89**, 1047–53 (*March* 1, 1953).

The relative yield of neutral mesons from various elements in the reaction (p, π^0) has been determined. Single photons from neutral meson decay were observed at 135° to the proton beam in the laboratory system. Detection was by means of a pair scattering detector composed of a converter and two anthracene crystal telescopes in juxtaposition. The yield in the range of elements from H to Na is essentially proportional to the number of neutrons; in the elements Al to Pb it is proportional to $(N/A)A^{\frac{1}{3}}$. A.

539.18

3621. Neutral meson production in n–p collisions. R. H. Hildebrand. *Phys. Rev.*, **89**, 1090–2 (*March* 1, 1953).

The angular distribution of neutral pions formed by 400 MeV neutrons in the process $n + p \rightarrow d + \pi^0$ has been measured using an experimental arrangement in which both of the π^0 decay γ-rays are detected in coincidence with the deuteron. The results can be described in the centre-of-mass system by the function $\cos^2\theta + 0{\cdot}2$. The agreement between this distribution and the π^+ distribution of the process $p + p \rightarrow d + \pi^+$, which has been measured by Whitehead and Richman and by Durbin, Loar and Steinberger, gives evidence in support of the hypothesis of charge independence in meson-nucleon interactions. A.

539.185

3622. A high sensitivity fission counter. W. Baer and R. T. Bayard. *Rev. sci. Instrum.*, **24**, 138–40 (*Feb.*, 1953).

The design and performance of a sensitive robust fission counter is described. The counter detects thermal neutrons by means of U^{235} fission. The sensitivity of the counter is $0{\cdot}7$ count/neutron cm^{-2} for a background counting rate of 5 counts/sec. The useful range is 10 to 2×10^5 neutrons/cm^2 sec, and the counter will operate over this range in the presence of 10^{10} γ-rays/cm^2 sec. A.

539.185

3623. A high transmission slow neutron velocity selector. J. G. Dash and H. S. Sommers, Jr. *Rev. sci. Instrum.*, **24**, 91–6 (*Feb.*, 1953).

A high intensity neutron monochromator for the subthermal energy region is described. The instrument utilizes the velocity selectivity of a rotating helix. A complete analysis is made of the instrument resolution for several practical constructions. For wavelengths longer than one Ångström, a mechanical selector may yield resolutions of 1·0 to 0·1 and fractional transmissions of 60%. Design and tests of a selector are described and compared with the theory. A.

539.185

3624. Neutron measurements with the Brookhaven crystal spectrometer. L. B. Borst and V. L. Sailor. *Rev. sci. Instrum.*, **24**, 141–8 (*Feb.*, 1953).

A new crystal spectrometer for slow neutron cross-section measurements is described in detail. Be has been found to be an exceptionally good neutron monochromator extending the useful range of crystal spectrometers to energies of about 50 eV with good resolution. The characteristics of crystals for use as neutron monochromators are discussed in regard to intensity of the Bragg reflection, resolution, spectral distribution, higher order contamination, and background. Evidence is presented concerning the precision of energy measurements with the BNL spectrometer. The energies of the lowest resonances in the following elements were found to be: Ir, $E_0 = 0{\cdot}654 \pm 0{\cdot}003$; Rh, $E_0 = 1{\cdot}260 \pm 0{\cdot}004$; In, $E_0 = 1{\cdot}458 \pm 0{\cdot}005$; Re, $E_0 = 2{\cdot}16 \pm 0{\cdot}01$; Au, $E_0 = 4{\cdot}93 \pm 0{\cdot}03$; and Ag, $E_0 = 5{\cdot}235 \pm 0{\cdot}035$ eV. Comparison with similar measurements made with time-of-flight spectrometers shows that the de Broglie equation for computing neutron wavelengths is valid to within about ½%, the precision of present-day experimental observations. A.

539.185

3625. Resonant scattering of slow neutrons. B. N. Brockhouse. *Canad. J. Phys.*, **31**, 432–52 (*March*, 1953).

A method is described for measurement, as a function of neutron energy, of the scattering cross-section for slow neutrons of materials having high absorption. The necessary corrections are discussed. The results are normalized to a V scattering cross-section of 5·07 barns inferred from the measured total cross-section, $\sigma_T = 5{\cdot}07 + 5{\cdot}29[0{\cdot}025/E(\text{eV})]^{\frac{1}{2}}$. Measurements are presented for the low-energy neutron resonances in Cd, Sm, Gd, Dy, Eu, Rh and In. The single level Breit–Wigner formula is accurately obeyed for Cd and Sm but not for Gd in which two resonances contribute. The scattering results indicate that the absorption cross-sections of Cd and Sm at resonance are higher than the values previously accepted. This has been confirmed by total cross-section measurements on Cd for which the Breit–Wigner parameters are $E_0 = 0{\cdot}180$ ($\pm 0{\cdot}003$) eV, $\Gamma = 0{\cdot}113$ eV, $\sigma_{a0} = 7750$ barns, $\sigma_P = 4{\cdot}7$ barns, $a_R = 7 \times 10^{-13}$ cm. The spin of the compound nucleus is unity. For Sm^{149} the spin of the compound nucleus (0·096 eV resonance) is $i + \frac{1}{2}$. The scattering cross-section of Eu for neutrons of energy 0·03 eV to 0·15 eV is 8 barns, almost independent of the energy. The scattering cross-section of Dy is 100 barns at 0·03 eV and decreases slowly with increasing energy, thus comfirming the existence of a level at negative neutron energy. The spin of the compound nucleus for the 1·26 eV resonance in Rh^{103} is found to be unity and that for the 1·45 eV resonance in In^{115} is found to be four. A.

539.185

3626. Neutron diffraction. G. E. Bacon and K. Lonsdale. *Rep. Progr. Phys.*, **16**, 1–61 (1953).

A description is given of the progress over the past few years of neutron diffraction, with particular reference to its applications, often alongside complementary X-ray studies, to investigations in structural crystallography and the physics of the solid state. This outlines the relevant principles of neutron scattering by nuclei and magnetic atoms and the way in which these processes determine the intensities of diffracted beams from single crystals and polycrystalline material. Details are given of the experimental determinations of the fundamental scattering amplitudes and cross-sections used in diffraction work, and tables of these quantities are included. A review of the physical and chemical problems on which significant information has already been obtained by neutron diffraction groups these problems under three main headings: structural investigations involving light elements, distinctions between atoms of closely similar atomic number, and studies of magnetic materials with particular reference to ferro-, antiferro- and ferri-magnetism. A list of about 150 references is appended. A.

STRUCTURE OF SOLIDS 539.2

539.215

3627. The theory of sintering. G. A. Geach. *Progress in metal physics, Volume* **4**, 174–204 (1953) [see Abstr. 3779].

A review. Discusses the process of sintering in various powder materials and the changes in physical properties occurring on application of different types and extents of treatment. Experiments on the porosity of the sintered material are described and conditions for different sintering rates (e.g. gas atmosphere, particle size, pressure) outlined. Various theoretical views on the process of sintering are briefly described. 80 references. E. P. Wohlfarth

539.215 : 539.217

3628. The sintering of powders and diffusion. R. S. Barnes. Letter in *Phil. Mag.*, **43**, 1221–4 (*Nov.*, 1952).

The decrease in density found initially on sintering mixed powders of dissimilar metals is attributed to the same causes that produce voids and concomitant density decreases during the interdiffusion of dissimilar metals [Abstr. 6791 (1952)]. A. D. Le Claire

539.215 : 513.468

3629. Dense random packing of unequal spheres. M. E. Wise. *Philips Res. Rep.*, **7**, 321–43 (*Oct.*, 1952).

A heap of rigid spheres has a given typical statistical distribution for their radii, and the spheres are densely

packed as they might be in a powder. "Dense random packing" is defined in a new way in terms of a probability distribution function w for tetrahedra; each tetrahedron has its vertices at the centres of four spheres for which every sphere has to touch the other three. Thus w is defined by 4 radii. Boundary effects are ignored. General equations for w are deduced and a possible numerical solution for one log-normal distribution of radii; this is used to obtain approximations for several of the most interesting geometrical properties of the heap. In this way, for example, the mean density and the mean number of interstices are found, and also a statistical distribution for the largest possible spheres that can go into the interstices, and one for the number of spheres touching one sphere of given radius. Finally, the system is discussed critically as a model for a real packed heap. The mathematical methods are also of interest: these apply (e.g.) little-known formulae of solid geometry and for integrating numerically in 2, 3 and 4 dimensions. A.

539.217

3630. Diffusion in metals. A. D. Le Claire. *Progress in metal physics, Volume* **4,** 265–332 (1953) [see Abstr. 3779].

A review of recent work [see Abstr. 6922 (1950) for a review of earlier work]. Discusses the following topics: the Kirkendall effect; grain boundary and surface diffusion; the mechanism of diffusion, including recent comparisons between experimental and theoretical values of the diffusion coefficient; recent experimental methods; advances in the formal theory of the process. 131 references.

E. P. WOHLFARTH

539.217

3631. Diffusion in metals in solid state. W. Seith and A. Kottmann. *Angew. Chem.*, **64,** *No.* 14, 379–91 (1952) *In German.*

Presents the theoretical aspect and the results of investigations on the relationship between the partial coefficients of diffusion as determined by radioactive methods and those evaluated from the shift of markings in diffusion bodies. If the constituents have different partial coefficients of diffusion, the diffusion is accompanied by changes of shape and dimension. New lattice planes appear on the side of the constituent having a lesser coefficient of diffusion. A shift of markings can be observed even in a monocrystal provided there is a concentration gradient of constituents with different partial coefficients of diffusion. Holes caused by diffusion have been found in systems Ag–Au, Ni–Cu, Ag–Pd, Ni–Au and Fe–Ni, and investigated quantitatively for Ag–Au. The flow of mass has been studied in connection with the formation of holes and the change of structure. It has been proved experimentally that the equation

$$D_i = D_i^*\left(1 + \frac{\partial \log_e f_i}{\partial \log_e N_i}\right)$$

where f_i is the activity coefficient of the constituent i while N_i is the mole fraction of the same constituent, illustrates the relationship between the partial coefficients of diffusion determined by radioactive methods and those evaluated from the shift of the markings. See also Abstr. 4644–5 (1952).

F. LACHMAN

539.217 : 537.312.6

3632. Self-diffusion in the alkali metals. D. K. C. MacDonald. Letter in *J. chem. Phys.*, **21,** 177–8 (*Jan.*, 1953).

An "anomalous" increase in the rate of rise with temperature of the electrical resistance R of the alkali metals is attributed to vacant lattice sites. Measurements of R lead to values for the energy of formation of vacancies in Li of $9{\cdot}3 \pm 0{\cdot}35$ and in Na and K of $9{\cdot}1 \pm 0{\cdot}1$ kcal/mole. This energy is identified [erroneously] with the activation energy for self-diffusion in these metals. A. D. LE CLAIRE

539.217

3633. Closed pores in synthetic graphite. E. M. Dresel and L. E. J. Roberts. Letter in *Nature* [*London*] **171,** 170 (*Jan.* 24, 1953).

The density of synthetic graphite is always less, by 2–8%, than the density of pure Ceylon graphite and the value obtained from X-ray measurements; the discrepancy is least when the graphite is finely powdered. A. R. STOKES

539.217

3634. The measurement of the hydraulic permeability of saturated soil *in situ*. II. E. C. Childs, A. H. Cole and D. H. Edwards. *Proc. Roy. Soc. A*, **216,** 72–89 (*Jan.* 7, 1953).

For Pt I, see Abstr. 2750 (1953). After a brief description of a new sand-tank laboratory and equipment for studying problems of the flow of fluids in porous materials, the remainder of the paper is devoted to an account of the application of a part of this equipment to a study of the flow of water between a pair of wells, such as is required for the determination of the permeability of the sand by the method described in Pt I. The potential distribution about the wells is found to conform sufficiently well with theory to justify the application of the analysis of Pt I, the interference due to the confining walls being satisfactorily negligible. The perturbation of the water table inseparable from the imposition of a potential difference between the wells is found not to invalidate the results based on an assumption of two-dimensional flow, while the corrections on account of the presence of a capillary fringe and a surface of seepage are satisfactorily made by adding to the measured depth of water in the well an increment equal to about half the thickness of the capillary fringe. The end correction for non-penetrating wells is also sufficiently well made by an addition to the measured depth of water; the magnitude of the correction is given for isotropic media for a well system of the dimensions used here, and the method of applying it to anisotropic media is indicated. The two-well method is used to estimate the permeability of the sand, which is then discussed in relation to the pore-size distribution. The elucidation of the permeability profile in a succession of strata is then discussed. Finally, techniques suited to work in the field are described, and a few preliminary field results are quoted. A.

539.217.5

3635. Septum permeation of hydrogen from flames. F. W. THOMPSON AND A. R. UBBELOHDE. *Proc. Roy. Soc. A*, **216**, 193–202 (*Jan.* 22, 1953).

Flames consist of maintained chemical reactions, and the concentrations of labile chemical species such as H atoms, may greatly exceed the concentrations for chemical equilibrium at the flame temperature. This should influence the attack on metals by flames. To test this, apparatus has been constructed for measuring the rate of permeation of H and other gases from flames through metal septa. Relative rates of permeation have been compared for a H/O/N flame: (1) with metal septa consisting of decarburized chrome steel, chrome steel, decarburized Cr/Ni alloy steel, or Ni; (2) with metal septa consisting of decarburized steel or Ni, when small quantities of SO_2 or H_2S are mixed with the H/O/N flame. For the different metals and the same reference flame (free from S) relative rates of permeation at around 820°C are in the sequence: Ni > chrome steel ≃ decarburized Cr/Ni alloy steel > decarburized chrome steel. Approximate relative rates are Ni, 1000; chrome steel, 300; decarburized chromium/Ni alloy steel 300; decarburized chrome steel 10. The addition of small quantities of SO_2 to the flame at once reduces the concentration of H atoms, as observed with a MoO_3 test. Comparable amounts of H_2S added to the flame have little or no effect. Both types of S compound rapidly change the rate of permeation of H through the metal septa from the flame. An increased permeation rate is observed for decarburized chrome steel, and a decreased permeation rate for a decarburized Cr/Ni/Fe alloy. An initial drop in permeation rate through chrome steel with SO_2 in the flame is probably due to the decreased concentration of H atoms. The subsequent effects for both SO_2 and H_2S are attributed to the formation of S compounds either on the surface or within the crystal lattice of the metals. A.

539.217.5 : 541.11/.12

3636. Gases in metals. C. R. CUPP. *Progress in metal physics, Volume* **4**, 105–73 (1953) [see Abstr. 3779].

A review. The relationships of metals with gases (inert gases, N, O, H) are discussed, the gas-metal equilibrium and the diffusion and solution of gases being considered. Effects of gases on the physical properties of metals are described, including the following: internal friction, photo-electric work function, lattice expansion, magnetic susceptibility and permeability, electrical conductivity, mechanical properties. Internal oxidation of metals is discussed and the process of evolution of gases during solidification of metals from the molten state is described. The embrittlement of metals by gases is also described. 246 references. E. P. WOHLFARTH

539.219 : 532.73

Methods of approximation in the theory of regular mixtures. *See Abstr.* 3009

539.232′: 539.217.5 : 541.11/.12

3637. The mechanism of oxidation of metals and alloys at high temperature. K. HAUFFE. *Progress in metal physics, Volume* **4**, 71–104 (1953) [see Abstr. 3779].

A review. The conditions for and the effects of the formation of a thick oxide layer on the metal surface are discussed, and the lattice defect theories of oxidation described. Processes involving ionic conducting and excess and defect semiconducting layers are described and interpreted on the basis of Wagner's theory. Oxide layers containing several phases are dealt with and alternative theoretical models assuming the layers to be thin are considered. 90 references. E. P. WOHLFARTH

539.27

3638. Direct examination of solid surfaces using a commercial electron microscope in reflection. J. W. MENTER. *J. Inst. Metals*, **81**, 163–7 (*Nov.*, 1952).

The modifications necessary for the conversion of the Metropolitan-Vickers EM3 electron microscope for use in the direct examination of solid surfaces by reflection are described. The geometry, resolution and depth of focus of the image are discussed. A range of specimens with widely varying surface topography have been examined in order to illustrate the value of the technique and to determine the effect on the image of varying the angle of inclination of the specimen. A.

539.27

3639. A high resolution replica technique. C. FERT AND R. DARGENT. *C.R. Acad. Sci.* [*Paris*] **235**, 1623–5 (*Dec.* 22, 1952) *In French.*

An aluminium film is evaporated on to the specimen surface, stripped off with cellotape and oxidized electrolytically. The oxide film is detached by dissolving away the cellotape and the remaining aluminium, and is caught on the specimen grid in the usual way. Results obtained are shown. R. S. PEASE

539.27

3640. Precipitation of radioactive particles in an intensely ionized electric field. M. PAUTHENIER AND R. CHALLANDE. *C.R. Acad. Sci.* [*Paris*] **236**, 69–70 (*Jan.* 5, 1953) *In French.*

A method reported earlier for investigating aerosols [Abstr. 1973 (1953)] was applied to radioactive particles. The deposited material was counted with a G.M. counter. F. R. HOLT

539.27 : 535.343.4–14

Electron diffraction and microwave investigation of tertiary butyl fluoride. *See Abstr.* 3137

539.27 : 537.533.72

Summarized proceedings of a conference on electron microscopy—Bristol, September 1952. *See Abstr.* 3351

539.27 : 537.533.74

3641. Scattering of electrons and contrast in the electron-micrographs of shadow-cast specimens. A. K. CHAUDHURI. *Proc. Nat. Inst. Sci. India*, **18**, 585–94 (*Nov.–Dec.*, 1952).

The part played by scattering of electrons in the formation of image by transmission type electron-microscopes has been discussed with special reference to shadow-cast electron-micrography. The thickness of deposit to produce desirable contrast in the image

has been theoretically calculated for a number of metals like gold, chromium, palladium, etc., suitable for shadow-casting. A large number of specimens has been shadowed according to theoretical considerations and found to produce well perceptible shadows. A.

539.27 : 539.234

3642. Electron diffraction study of Cu–Al alloys prepared by evaporation *in vacuo*. J.-J. TRILLAT AND N. TAKAHASHI. *C.R. Acad. Sci.* [*Paris*] **235**, 1306–8 (*Nov.* 24, 1952) *In French.*

Cu and Al in known proportions were simultaneously evaporated on to freshly cleaved rock-salt which was subsequently dissolved away. Films of alloy thus prepared with the rock-salt at room temperature gave only poorly defined diffraction patterns; but with the rock-salt at 300°C excellent patterns were obtained, which showed the presence of the phases appropriate to the proportions of Cu and Al used in the evaporation. R. S. PEASE

539.27 : 548.74

3643. Electron microscopy and diffraction study of the behaviour of silver bromide under the action of fast electrons. J.-J. TRILLAT. *C.R. Acad. Sci.* [*Paris*] **236**, 60–2 (*Jan.* 5, 1953) *In French.*

Micrographs show that the films of AgBr described previously [Abstr. 7673 (1952)] giving single-crystal diffraction patterns, consist of a mass of highly oriented and irregularly shaped particles. Under the action of ~50 kV electrons, globules of silver appear inside or close to the initial AgBr particles of which only faint outlines finally remain. The silver globules show slight preferred orientation. R. S. PEASE

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

3644. Higher approximations of relaxation spectra. F. SCHWARZL AND A. J. STAVERMAN. *Physica*, **18**, 791–8 (*Oct.*, 1952).

To obtain relaxation or retardation spectra from experimental data, approximation calculations must be made. A method of calculating the spectra in successive approximations is developed and indications are given for devising experimental methods specifically suited to the determination of spectra. A.

539.31

3645. Experiments on the mechanics of rubber. II. The torsion, inflation and extension of a tube. J. R. GOULD. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 905 (*Nov.*, 1952).

The fractional change of volume for a model of rigid inextensible rods is compared with that derived by Gent and Rivlin [Abstr. 6799 (1952)] for rubber. J. E. CAFFYN

539.32 : 541.64

3646. On the temperature dependence of the modulus of elasticity in high polymers. E. KLEIN AND E. JENCKEL. *Z. Naturforsch.*, **7a**, 800–7 (*Dec.*, 1952) *In German.*

Deformation curves for linear and cross-linked polystyrene and linear PMA-ster are reported. An energetic and a statistical E-modulus are deduced; the latter is directly proportional to T (abs.) and the degree of cross-linking. This result leads to an analogy with the ideal gas law, $E_{\text{stat.}} V = RT$ without additional numerical factor. J. JACOBS

539.37

3647. A dislocation model for the study of boundary phenomena and deformation in metals. W. I. PUMPHREY. Letter in *Nature* [*London*] **171**, 218 (*Jan.* 31, 1953).

The cut ends of a pile of several hundred steel rods ($\frac{1}{16}$ – $\frac{1}{8}$ in. dia.), stacked with the ends in the same vertical plane, present a pattern which is a useful representation of the atomic arrangement in a polycrystalline metal, revealing grain boundaries, dislocations, etc., and which constitutes a model more robust than one of soap bubbles, particularly for studying the effect of rapidly applied loads. A. D. LE CLAIRE

539.37

3648. Theory of dislocations. A. H. COTTRELL. *Progress in metal physics*, *Volume* **4**, 205–64 (1953) [see Abstr. 3779].

A review of recent work [see Abstr. 6922 (1950) for a review of earlier work]. Discusses the following topics: growth of imperfect crystals, including theoretical work by Frank and recent experiments on growth steps on crystal surfaces; static creation of dislocations (Frank–Read source); dynamic properties; characteristic dislocations in the various crystal structures; growth of deformation twins; dislocations in crystal boundaries and in slip bands, and the obstruction of dislocations at grain boundaries; dislocation "jogs" and the creation of vacancies; recent work on the author's theory of the yield point and strain ageing, and on the theory of work hardening, annealing (polygonization) and creep. 160 references. E. P. WOHLFARTH

539.373

3649. A magnetic analog for the interaction of dislocation loops. E. W. HART. Letter in *J. appl. Phys.*, **24**, 224–5 (*Feb.*, 1953).

Shows that the analogy (force exerted on a dislocation by an external stress field analogous to that exerted on a current-bearing wire by an external magnetic field) is even more complete than in the case discussed by Peach and Koehler [Abstr. 2094 (1951)] for the interaction of dislocations moving only in the plane defined by the dislocation line and the Burgers vector. E. P. WOHLFARTH

539.374

3650. Residual stresses and strains in molded plastics. W. H. MARKWOOD, JR AND H. M. SPURLIN. *J. Colloid Sci.*, **7**, 244–52 (*June*, 1952).

A simple model is used to compare the flow and recovery of ethyl cellulose and cellulose acetate at different temperatures. The effect of deforming samples at one temperature and measuring the stress relaxation at another is discussed. J. E. CAFFYN

539.374 : 539.434

3651. The flow of metals. E. N. DA C. ANDRADE. *J. Iron Steel Inst.*, **171**, 217–28 (*July*, 1952).

Hatfield Memorial Lecture, April 30th, 1952.

539.374

3652. Role of deformation bands in the plastic deformation of metallic single crystals. H. NISHIYAMA AND J. TAKAMURA. *Tech. Rep. Engng Res. Inst. Kyoto Univ.*, **2**, 139–70 (*Oct.*, 1952).

Electrolytically polished single crystal strips of Al (99·96% and 99·99% purity) and Cu (99·94%) were extended at rates between 10^{-4} and 10^{-2}% per sec. while suspended with freedom to twist. Deformation bands were observed in the (101) planes in both metals and studied by X-ray techniques. X-ray asterism is associated with the boundaries between regions of simple slip and deformation bands. The effect of the crystallographic orientation of the specimen on the deformation bands, and the effect of the bands on the stress-strain relation, are discussed.

J. G. OLDROYD

539.374

3653. The deformation by repeated blows of single crystals of Al–Cu alloy. Y. PIRONNEAU. *C.R. Acad. Sci.* [*Paris*] **236**, 46–8 (*Jan.* 5, 1953) *In French.*

An apparatus is described which submits specimens (4% Cu) to a series of tensile impulses. The extensions produced are proportional to the number of blows applied and so to the energy absorbed. The asterism of Laue reflections from impulsively deformed specimens is more marked than from specimens deformed the same amount in simple tension, and in the former case, for the similarly oriented specimens employed, the deformation is by slip on all 4 ⟨111⟩ planes but in the latter only on one set of planes.

A. D. LE CLAIRE

539.374

3654. Plastic properties of coking coals. J. BRONOWSKI, D. FITZGERALD, D. W. GILLINGS AND D. C. RHYS-JONES. Letter in *Nature* [*London*] **171**, 389–90 (*Feb.* 28, 1953).

A viscosity-time relation is deduced for coking coals in the temperature range 300–400°C. It is assumed that the coking coal behaves as a liquid, decomposes to an infusible mass and a gas, by a first-order chemical reaction, and that a viscosity concentration relation of the Einstein type is valid. Measurements at different temperatures enable activation energies to be calculated and four are quoted.

J. E. CAFFYN

539.374

3655. Viscoelastic properties as functions of the distribution of activation energies. W. J. LYONS. *J. appl. Phys.*, **24**, 217–21 (*Feb.*, 1953).

1. Assuming that the elementary molecular deformation process conforms to the Maxwell model, and that the molecular elastic force G_i and viscous force η_i are functions (of unspecified forms) of the free energy of activation F^*, the following expressions for the dynamic modulus G_d and dynamic viscosity (internal friction) η_d are obtained:

$$G_d = \frac{1}{A}\int_0^\infty \frac{\omega^2\tau_i^2 G_i \phi(F^*)}{\omega^2\tau_i^2 + 1} dF^*,$$

and

$$\eta_d = \frac{1}{A}\int_0^\infty \frac{\eta_i \phi(F^*)}{\omega^2\tau_i^2 + 1} dF^*,$$

where A = area of sample, $\tau_i = G_i/\eta_i$, ω = vibration frequency, and $\phi(F^*)dF^*$ = the *number* of elementary processes having activation energies lying between F^* and $F^* + dF^*$.

2. By employing an expression relating the relaxation time τ_i with F^* for the elementary process, and adopting the so-called "box" distribution of relaxation times, the following explicit form for the distribution of activation energies is deduced: $\phi = \text{const}\ (1/kTF^* - 1/F^{*2})$, where k = Boltzmann's constant and T = absolute temperature. When the box distribution, as represented by this explicit form for ϕ, is introduced into the foregoing expressions for G_d and η_d, the integrated results are found to predict temperature and frequency dependencies which are in gratifying agreement with experiment.

A.

539.374

3656. Model to illustrate the behaviour of fixed base portal frames in the plastic range. M. R. HORNE. *Brit. J. appl. Phys.*, **4**, 54–5 (*Feb.*, 1953).

The model described reproduces the modes of collapse of a fixed base steel portal frame as predicted by the plastic theory. It is composed of light alloy cubes held together by fine steel wires, the tensions in which determine the strengths of the corresponding members in the structure. Good quantitative agreement is obtained between the observed and theoretical loads necessary for collapse. It is suggested that similar models could be constructed to study the behaviour of more complicated frames.

A.

539.374 : 537.312.9

3657. The change of resistivity of silver and gold on plastic deformation. W. H. AARTS. *S. African J. Sci.*, **49**, 183–4 (*Dec.*, 1952).

The change of resistivity of silver, gold and their alloys of 50 and 2% gold are given. The considerably higher value of the change in resistivity of the 50% alloy is discussed and compared with a similar effect in some copper alloys. It is suggested that the large change of resistivity in some alloys may be due to the disruption of partial order by the passage of dislocations.

A.

539.38

3658. Critical shear stress and temperature. E. N. DA C. ANDRADE. Letter in *Phil. Mag.*, **43**, 1218–21 (*Nov.*, 1952).

The difference in the mechanical behaviour of hexagonal and cubic metals may be less fundamental than often supposed because (1) under suitable conditions glide in cubic metals can be restricted to one set of planes, and (2) when the critical shear stress σ is plotted against T/T_m, T being the temperature of test and T_m the melting point, there is no indication of grouping according to structure, as appears with the stress-strain curves. Orowan's (1934) relation $\sigma = \sigma_0 - BT^{1/2}$ (σ_0 and B constants) is obeyed in the range $0{\cdot}05 < T/T_m < 0{\cdot}4$ at least for Au, Ag, Cd and Zn.

A. D. LE CLAIRE

539.38

3659. The structure of deformation bands. E. W. HART. Letter in *Phys. Rev.*, **89**, 521 (*Jan.* 15, 1953).

A group of pairs of edge dislocations with opposite sign is shown to form a stable array with properties similar to those of deformation bands. Cahn's

measurements (1951) of the angle between deformation bands and the normal to the slip plane in Al, are consistent with the predictions of this model.

A. D. LE CLAIRE

539.4 : 536.62

3660. Measurements on the evolution of heat during the recovery of cold-worked metals. G. BORELIUS, S. BERGLUND AND S. SJÖBERG. *Ark. Fys.*, **6**, *Paper* 16, 143–9 (1952).

Calorimetric measurements are reported on rods of pure Al, Cu and Zn at 100°C, during recovery after cold-working at room temperature. The rate of evolution of heat decreases as the reciprocal of the time, if the measurements are begun immediately after the cold-working, or as 1/(time + constant) if there has been partial recovery at a lower temperature first. A theoretical explanation is discussed. The precautions taken to avoid experimental errors are described.

J. G. OLDROYD

539.4.011.1

3661. The compression and bearing capacity of cohesive layers. G. G. MEYERHOF AND T. K. CHAPLIN. *Brit. J. appl. Phys.*, **4**, 20–6 (*Jan.*, 1953).

A theoretical study of the compression of blocks and cylinders of purely cohesive material between rough plates shows that the yield pressure of the blocks and cylinders increases with the roughness of the plates and with decreasing height of the specimen. Compression tests of blocks and cylinders of Plasticine and clay between perfectly rough plates are found to be in good agreement with the theory. The above analysis has been extended to obtain an estimate of the yield pressure of footings on cohesive layers; theoretically the bearing capacity should increase with the adhesion of the material on the footing and base and with decreasing thickness of the layer. The results of some loading tests on circular and strip model footings on Plasticine layers with a perfectly rough base conform with the theory.

A.

539.4.011.25

3662. A note on the velocity of crack propagation in glass. H. RAWSON. *J. Soc. Glass Technol.*, **36**, 297T–299T (*Dec.*, 1952).

Yoffe's calculations [Abstr. 8274 (1951)] are used as basis for an explanation of the existence of a maximum velocity of crack propagation; it is suggested that this maximum is for propagation in a straight line only.

539.4.016

3663. The mean shear stress in an array of dislocations and latent hardening. A. N. STROH. *Proc. Phys. Soc.* [*London*] *B*, **66**, 2–6 (*Jan.*, 1953).

The root mean square shear stress on a slip plane due to an array of dislocations is taken as a measure of the work hardening of that plane. The ratio of the hardening of the latent slip system to that of the operative system, which is shown to be independent of the distribution of the dislocations, is calculated both for screw and for edge dislocations. Numerical values are given for the twelve slip systems of face-centred cubic crystals. The results suggest that hardening by edges may account for the greater part of the observed latent hardening.

A.

539.42

3664. Intercrystalline cracking of metals. J. N. GREENWOOD. Letter in *Bull. Inst. Metals*, **1**, 104–5 (*Aug.*, 1952).

The aggregation of vacant lattice sites is suggested as the mode of initiation of cracks internally in metals. If it is postulated that (*a*) the empty spaces migrate under the joint action of stress and thermal movement in the direction of a tensile stress, and (*b*) grain boundaries across which a tensile stress is maintained can more readily accommodate vacant sites, the latter would accumulate in boundaries which lie at right angles to the stress direction; conditions for the breaking of cohesive bonds will occur, i.e. an intercrystalline crack will start, which will open out under the continued stress. This hypothesis is illustrated by photographs of ball models.

539.42

3665. Intercrystalline cracking of brass. J. N. GREENWOOD. Letter in *Bull. Inst. Metals*, **1**, 120–1 (*Oct.*, 1952).

Observations which tend to modify the author's hypothesis (preceding abstract) though confirming its general principles.

539.42 : 539.374

3666. A machine for tensile testing at controlled temperatures and constant true strain rates. E. L. BARTHOLOMEW, JR, K. J. KRYSTYAN, D. A. J. MILLAR AND J. WULFF. *Rev. sci. Instrum.*, **24**, 196–202 (*March*, 1953).

The machine performs short-time tensile tests at constant temperature and constant true strain rate. It automatically measures and controls the minimum diameter of a cylindrical specimen which is pulled in a constant temperature furnace. A cam drive establishes the required exponential variation of diameter with time, and, by means of an optical comparator and error-operated servo, the testing machine pulls the specimen at the required rate. Load is determined by measuring the deflection of weigh-bars in series with the specimen. Since true strain increases linearly with time, a true stress, true strain curve can be plotted from yield to fracture. The information obtainable with this machine should be of considerable value in hot-working research, and will complement that available from creep and stress rupture tests.

A.

539.42 : 541.15 : 621.357.9

3667. The experimental production of small tensile specimens by electrolytic solution (electro-turning). M. H. FARMER AND G. H. GLAYSHER. *J. sci. Instrum.*, **30**, 9–10 (*Jan.*, 1953).

An apparatus was assembled to turn the gauge length of Chevenard tensile specimens, which are only 1½ mm in diameter, by electro-chemical means instead of by normal lathe turning. The latter causes undesirable surface deformation. Specimens about 19·0×3·18 mm diameter were rotated at 2000 rev/min and moved to and fro along the axis of rotation at constant velocity while a stationary jet of electrolyte impinged radially on to the surface to be removed. Using a hydrochloric acid/copper ammonium chloride solution, the diameter of iron specimens could be reduced by 1·6 mm in 15 min and a good polish produced on the surface. The stress/strain curves of

normalized pure iron specimens produced by electro-turning and by machining were compared. The yield point, which is easily obliterated by cold work, was shown only on the curves of the electrolytically produced specimens. A.

539.43

3668. Exudation of material from slip bands at the surface of fatigued crystals of an aluminium–copper alloy. P. J. E. FORSYTH. Letter in *Nature* [*London*] **171**, 172–3 (*Jan.* 24, 1953).

A 4% Cu alloy. Thin sheets of material, showing extrusion and other markings and with their leading edges curled over, are exuded from those bands which in the early stages of the cyclic stressing appear most marked. These may extend the length of the band but usually break into segments. A. D. LE CLAIRE

539.434

3669. Surface effects and the creep of the zinc single crystals: I. Creep characteristics of clean and oxide-coated crystals. F. D. COFFIN AND A. L. WEIMAN. *J. appl. Phys.*, **24**, 282–8 (*March*, 1953).

Quantitative studies of the influence of the surface composition on the creep of Zn single crystals under constant loads have been carried out. The creep curves of crystals with clean and oxidized surfaces were obtained in air and in acid. It is shown that a continuous layer of oxide strengthens the crystal only at low loads, and that the presence of cracks in this layer allows the metal to creep at its normal rate. These facts support the theory that the oxide film acts to relieve the metal of part of the load. An increase in creep rate is observed when the pure metal surface is treated with dilute mineral acids. The heat liberated by the reaction is considered as a possible explanation of the sudden increase in creep rate when the surface layer of the crystal is removed. The normal creep curves of unoxidized crystals in air may be described by an empirical equation of a new form, and its application to other types of curves obtained is discussed. A.

539.62

3670. The laws of friction. H. G. HOWELL. Letter in *Nature* [*London*] **171**, 220 (*Jan.* 31, 1953).

Some simple consequences are noted of a law: friction $\propto$ (normal reaction)^n. Such a relation has been observed for Nylon and viscose and cellulose acetate rayon fibres, with n between 0·67 and 1·0.

J. G. OLDROYD

539.62

3671. The nature of the coefficient of friction. J. T. BURWELL AND E. RABINOWICZ. *J. appl. Phys.*, **24**, 136–9 (*Feb.*, 1953).

The modern theory of the friction between dry metal surfaces ascribes it to local minute welds or adhesions between the surfaces and suggests that for a given pair of surfaces the friction force is uniquely defined by the normal load alone. Herein it is demonstrated that this cannot in general be true and that some further condition of operation must also be defined. Experiments are reported indicating that one such possible condition is the sliding speed so that the friction force is actually a function of the normal load and the sliding speed. It is pointed out that the speed can influence the friction force in two ways—one, by the resulting shear strain rate in the vicinity of the welded junction, and the other by the length of time taken for a junction of full strength to form. A.

539.67

3672. The internal friction and elastic properties of solid, liquid and gaseous bodies. II. E. SKUDRZYK. *Österr. Ingen. Arch.*, **6**, *No.* 3, 157–96 (1952) *In German.*

See Abstr. 1284 (1950). Under the conception of internal friction are usually included all those phenomena which lead to an irreversible generation of heat from mechanical energy. Internal friction is thus caused by simple relaxation phenomena, thermic effects, complicated elastic lags, mechanical hysteresis and plastic flow. The various components of internal friction as determined by simple vibration measurements give a fair insight into the mechanical properties and the physical structure of the material. A.

539.67

3673. Internal friction of quartz. G. A. ALERS. *J. appl. Phys.*, **24**, 331–7 (*March*, 1953).

The internal friction of quartz was studied by measuring the logarithmic decrement of a bar vibrating in resonance at its fundamental mode at 21 kc/s and at its second harmonic mode at 42 kc/s as a function of temperature from 200°c to 440°c. The logarithmic decrement was found to rise rapidly to a maximum of 16×10^{-5} at about 240°c, then fall slowly to a minimum of about 8×10^{-5} at about 350°c, and then rise rapidly up to and beyond 460°c. The high temperature portion shows a temperature hysteresis in which the cooling curve is lower than the heating curve. Furthermore the magnitude and, to a certain extent, the position of the peak may depend upon previous history but heating in a vacuum can reduce the logarithmic decrement curve to a reproducible one, independent of room temperature handling and thermal gradients (up to 1·5°c/cm) or stress amplitudes (up to 10 g/mm^2) applied at higher temperatures. The measured curve can be considered as the sum of two relaxation peaks and an exponential curve. One peak has an activation energy of $27\cdot2\times10^3$ calories per mole, and the other, $12\cdot6\times10^3$ calories per mole. The exponential curve appears to be characterized by an activation energy of about 22×10^3 calories per mole but may vary with heat treatment. A.

539.67

3674. Internal friction in metals. A. S. NOWICK. *Progress in metal physics*, *Volume* **4**, 1–70 (1953) [see Abstr. 3779].

A review. The phenomenological theory of internal friction (homogeneous, inhomogeneous strain) is discussed. Visco-elasticity is considered, the "standard linear solid" being first discussed and the need for considering in general several relaxation times being stressed. Static hysteresis effects are also dealt with. Methods of measurement are described. The effects of stress on the degree of ordering in alloys and the influence on internal friction is discussed. The fact that internal friction may occur at interfaces in the metal is noted. The relation of internal friction to plastic phenomena is pointed out and relevant theoretical and experimental work

discussed. Thermo-elastic and magneto-elastic effects are also considered. 149 references.

E. P. WOHLFARTH

539.89 : 532.25

Limiting conditions for jet formation in high velocity collisions. *See Abstr.* 2994.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.124

3675. Kinetics of the gas phase reaction between acetylene and ozone. R. D. CADLE AND C. SCHADT. Letter in *J. chem. Phys.*, **21**, 163 (*Jan.*, 1953).

The reaction was followed by the i.r. absorption of ozone at 1040 cm^{-1} and acetylene at 735 cm^{-1}, the products being transparent at these wave numbers. An average rate constant of 0·0025 mm^{-1} sec^{-1} and an activation energy of 4·8 kcal/mole were determined at 30°c for varying ranges of pressure and concentration. The absence of the 3300 cm^{-1} hydroxyl band in both the gas and liquid phases suggest a similar reaction mechanism.

H. H. GREENWOOD

541.124

3676. The unimolecular decompositions of some alkyl bromides. J. H. S. GREEN, G. D. HARDEN, A. MACCOLL AND P. J. THOMAS. Letter in *J. chem. Phys.*, **21**, 178 (*Jan.*, 1953).

The decompositions may proceed by elimination of HBr in a single step or by the breaking of a C–Br bond. The parameters of the Arrhenius equation for the former have been studied by inhibiting the chain mechanism initiated by the liberated bromine atoms in the latter reaction. The parameter $A \sim 10^{13}$ is characteristic of unimolecular reactions and shows no significant difference for primary bromides. The activation energy is of the order of 50, 46 and 42 kcal for primary, secondary and tertiary bromides respectively, being much more dependent upon the strength of the C–Br bond than upon the C–H bond broken.

H. H. GREENWOOD

541.124

3677. Kinetics of the isotopic exchange reactions between the ion I and different aliphatic, alicyclic, and aromatic iodides. S. MAY, A. FAVA AND B. GIRAUDEL. *C.R. Acad. Sci.* [*Paris*] **236**, 286–8 (*Jan.* 19, 1953) *In French.*

The reactions with aliphatic and alicyclic iodides are characterized by roughly similar velocity constants and energies of activation. With aromatic iodides the reactions are more complex and depend strongly upon the physical conditions, e.g. the nature and surface of the walls of the containing vessel. It is not possible therefore to deduce a significant activation energy.

H. H. GREENWOOD

541.124

3678. The thermal decomposition of nitromethane. L. J. HILLENBRAND, JR AND M. L. KILPATRICK. *J. chem. Phys.*, **21**, 825–35 (*March*, 1953).

A study of the thermal decomposition of nitromethane was made by the flow method, with N as carrier gas, the reaction being followed by polarographic analysis of the effluent from the furnace for nitromethane. When carefully dried N was used the rate of disappearance of nitromethane became erratic; it was, however, found possible to obtain reproducible results by passing wet N through the unit before the kinetic run. The decomposition follows the first-order law, and over the range 420–480°c is represented by the equation $k = 2 \cdot 7 \times 10^{13} \exp(-50\,000/RT)$ sec^{-1}. At 420°, k is in good agreement with the value obtained by Cottrell, Graham and Reid by the static method, but at higher temperatures the observed rate is lower than that computed from their equation. Although the energy of activation is close to that required to break the C–N bond, the high initial yield of formaldehyde obtained in the flow-method experiments suggests that the rate is in part determined by an intramolecular arrangement.

A.

541.124 : 535.343.2–15

3679. A study, by means of infrared absorption spectra, of some reactions in the solid state. C. DUVAL AND J. LECOMTE. *Bull. Soc. Chim. France*, **20**, 203–6 (*Feb.*, 1953) *In French.*

Chemical bonding or the physical juxtaposition of the components of a compound in the solid state may be detected by comparing the infrared absorption spectra with those of the individual components and of a synthetic mixture. The method is exemplified by application to addition reactions and to reactions in which either a gaseous product or other solid products are formed.

H. H. GREENWOOD

541.124 : 536.46

3680. The slow combustion of cyclopropane. I. General kinetics. A. C. MCEWAN AND C. F. H. TIPPER. *Proc. Roy. Soc. A*, **216**, 280–91 (*Jan.* 22, 1953).

The kinetics of the reaction between O and *cyclo*propane have been investigated by the static method in the range 380 to 430°c, and with partial pressures of the reactants between 40 and 400 mm. There is an initial period of negligible pressure change, the rate then accelerating exponentially to a maximum. The effect of conditions on three rate characteristics—the maximum rate ($\rho_{max.}$), the net branching factor (A') and the induction period (θ)—obtained from the pressure-time curves, has been studied. These characteristics are very sensitive to surface conditions. Addition of N has no effect, but addition of H reduces the rate, probably owing to removal of some reaction product from the vessel wall. With lower O pressures $\rho_{max.}$ is proportional to both the O and *cyclo*propane pressures, while with higher O pressures it varies as the square of the *cyclo*propane pressure and is independent of the O pressure. The variation

of A' is similar to that of $\rho_{max.}$ $1/\theta$, however, is proportional to the *cyclo*propane and probably to the O pressure. The overall activation energy for $\rho_{max.}$ or A' is about 35 kcal, and for $1/\theta$ about 53 kcal. No detailed reaction scheme is proposed in this part. The results are discussed from the general point of view that the oxidation involves a chain mechanism with degenerate branching, and it is shown that the initiation step is probably heterogeneous. A.

541.124 : 539.13

3681. A detailed formulation of kinetic processes. II. The role of collision processes. S. W. Benson and A. E. Axworthy, Jr. *J. chem. Phys.*, **21**, 428–33 (*March*, 1953).

For Pt I, see Abstr. 6831 (1952). A detailed treatment is given of the activational processes occurring in both unimolecular and bimolecular processes. Such a treatment leads very naturally to the postulate of two critically energized species, one related to the products and one to reactants. In the case of unimolecular isomerizations it is shown that the properties of either one or both of these species may dominate the rate of the nonequilibrium reaction rate expression and the form of the rate expression is given in terms of the Slater theory of unimolecular reactions. In the case of unimolecular decompositions, only the complex corresponding to reactants is important, whereas in the inverse case of association reactions only that for the products is of importance. Both of these types of reactions have the same form of pressure dependence in the steady-state concentration region. The above considerations apply even when the reactions are not reversible. That is, the critically energized complex related to products is still of importance in determining the reaction rate. In the case of bimolecular and higher order processes, a detailed investigation shows that the activational processes are always maintained at their equilibrium values, and there is no region in which the rate constants will show a significant dependence on concentration of inert gas. A.

541.126

3682. Chain reactions with two diffusing active centres. V. V. Voevodskiĭ and A. S. Kompaneets. *Zh. eksper. teor. Fiz.*, **23**, *No.* 2 (8) 229–35 (1952) *In Russian.*

Equations are investigated for the kinetics of such chain reactions. It is shown that on very general physical assumptions no essential changes are introduced into the kinetics as compared with the case involving the diffusion of a single centre, and that there is no appearance of new limits of inflammability. Comparable concentrations of two carriers appear when the two are of comparable activity, or when, due to great discrepancies in concentrations of components of the reaction mixtures, the two active centres are removed at comparable rates though differing in activity. The theory explains how the simpler considerations of Semenov agreed with experiment though not strictly applicable.

E. Rabkin

541.127

3683. On the variation of the velocity of explosive waves with tube-diameter. H. Guénoche and N. Manson. *C.R. Acad. Sci.* [*Paris*] **235**, 1617–19 (*Dec.* 22, 1952) *In French.*

Rotating-mirror photographs of simultaneous detonation waves in parallel tubes of different dia. containing acetylene-O_2 and propane-O_2 mixtures have been analysed to reveal the effect of tube dia. on detonation velocity. The effect of other sources of variation is eliminated by this comparative technique. It was found that det. velocity $D = D_i \exp(-f(c,r)/r)$ where D_i is an ideal velocity, r is tube radius, and $f(c,r)$ is a function depending on the gas-composition and on the tube radius. A. Schofield

541.127

3684. The kinetics of oxidation of benzaldehyde. I. Survey of the reaction in solution. M. F. R. Mulcahy and I. C. Watt. *Proc. Roy. Soc. A*, **216**, 10–29 (*Jan.* 7, 1953).

For the study of the mechanism of oxidation of hydrocarbons and other organic compounds it is desirable to find systems suitable for kinetic study in which the mechanism of peroxide formation is not complicated by autocatalysis. The oxidation of benzaldehyde in benzene solution in the absence of light has been examined from this point of view. It was found that in the absence of catalysts and inhibitors consistently reproducible rates of oxidation are to be obtained only with special precautions in the preparation and handling of the materials. For a short period after the beginning of the reaction, the amount of peroxide in the solution corresponds closely to the oxygen taken up. There is no sign of autocatalysis. The reaction, on the contrary, is self-inhibiting. The rate of oxidation is extremely sensitive to the presence of inhibitors, the effect of 10^{-6} mole β-naphthol/mole solution being easily detected. The reaction is catalysed by dibenzoyl peroxide according to the relationship $\rho = \rho_u + \kappa[Bz_2O_2]^{\frac{1}{2}}$, ρ and ρ_u being the initial rates in the presence and absence of dibenzoyl peroxide respectively and κ a constant. Two conclusions are drawn from this result: (i) in the peroxide catalysed reaction the chains are terminated by mutual interaction, and (ii) the mechanism of the uncatalysed dark reaction involves different chain carriers from those of the catalysed reaction. In the presence of dibenzoyl peroxide both reactions take place simultaneously but independently. The oxidation is also catalysed, though in a rather more complicated manner, by Pyrex glass. A.

541.127

3685. The kinetics of oxidation of benzaldehyde. II. The kinetics of the uncatalyzed reaction in solution. M. F. R. Mulcahy and I. C. Watt. *Proc. Roy. Soc. A*, **216**, 30–44 (*Jan.* 7, 1953).

The initial rate of oxidation of benzaldehyde in benzene solution in the absence of catalysts and inhibitors is given by the relation

$$-\frac{d[O_2]}{dt} = \frac{[RH]^2[O_2]}{b[RH]^2 + c[O_2]}.$$

The reciprocals of the constants b and c vary with temperature according to the Arrhenius equation, the corresponding activation energies being $6{\cdot}0 \pm 0{\cdot}5$ and $17{\cdot}5 \pm 1{\cdot}0$ kcal/mole respectively. The difficulty of interpreting the relation in terms of the

mechanism proposed by Bolland and Gee (1946) for photochemical and peroxide catalysed oxidations is pointed out. It is suggested that this kinetic behaviour is of widespread occurrence in uncatalysed oxidations. A.

541.127 : 541.132

3686. Kinetics of the dissociation of the hydroferrocyanic ion in aqueous solution. G. EMSCHWILLER. *C.R. Acad. Sci.* [*Paris*] **236,** 72–4 (*Jan.* 5, 1953) *In French.*

The hydroferrocyanic ion in aqueous solution undergoes a spontaneous dissociation into cyano and ferropentacyano complex ions. The dissociation has been followed quantitatively, opposing reactions being avoided by the removal of one or other of the products. The velocity constants and the energy of activation have been calculated. H. H. GREENWOOD

ELECTROCHEMISTRY 541.13

541.135.5 : 548.5

The structure and orientation of calomel formed on liquid mercury by anodic polarization. *See Abstr.* 3713

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

3687. Chemical actions of ionising radiations in solutions. X. The action of X-rays on ammonia in aqueous solution. T. RIGG, G. SCHOLES AND J. WEISS. *J. Chem. Soc.*, **1952,** 3034–8 (*Aug.*).

It has been found that ammonia in dilute aqueous solutions is oxidized to nitrite at room temperature by the action of the radicals produced by irradiation with X-rays, provided that molecular oxygen is present. The influence of pH, concentration, and other factors on this process has been investigated. Hydroxylamine is apparently not involved as an intermediate. Attention has been drawn to the related biological process. A.

541.15

3688. The molecular yield in the decomposition of water by hard X-rays. E. R. JOHNSON AND A. O. ALLEN. *J. Amer. Chem. Soc.*, **74,** 4147–50 (*Aug.* 20, 1952).

Dilute aqueous solutions of a number of oxidizing and reducing agents at various concentrations give on irradiation with hard X-rays identical initial yields of hydrogen gas. This yield of molecular hydrogen is therefore characteristic of the action of X-rays on water, and occurs simultaneously with the formation of free radicals which react with solutes. The molecular yield is decreased about 18% by addition of 4% of sulphuric acid to the water. A.

541.15

3689. Hydrogen peroxide formation by cobalt gamma-radiation. T. J. SWORSKI. Letter in *J. chem. Phys.*, **21,** 375–6 (*Feb.*, 1953).

In 0·8N H_2SO_4, both air-saturated and He-saturated, H_2O_2 formation by Co γ-radiation is linear with dose; but in air-saturated pure water it rises to a steady maximum. The effect in acid may be attributed to the presence of a radical remover. The rate of H_2O_2 formation following complete ceric sulphate reduction is the same as that in the air-saturated acid. Ceric sulphate reduction in oxygenated solutions may take place through H_2O_2 intermediary rather than by reaction with OH or HO_2 radicals. Observations on ferrous sulphate oxidation are also recorded.

C. B. ALLSOPP

541.15 : 537.533

3690. The formation of hydrogen peroxide on fresh metal surfaces. L. GRUNBERG. *Proc. Phys. Soc.* [*London*] *B,* **66,** 153–61 (*March,* 1953).

The recent discovery by Kramer (1949–51) that freshly exposed metal surfaces emit electrons is considered to be the cause of the Russell effect and of Shaw's mechanical activation. Electrons originating from the surface initiate reactions involving free radicals. With water, in the presence of O, this leads to the formation of H_2O_2. Metals were cut under water containing O and it was found that, under similar conditions, Zn, Al, Mg and Ni yield approximately the same quantity of H_2O_2. Fe gives ferric ions and Cu only very little H_2O_2. During cutting, considerable quantities of hydroxides become suspended in the solution. With Zn more H_2O_2 is formed per cut in the early stages of the experiment, owing to the exposure of fresh surface by the dissolution of $Zn(OH)_2$. In the later stages each Zn atom exposed is responsible for the formation of approximately 1·5 molecules of H_2O_2. The decomposition of H_2O_2 in the presence of chips of Zn is found to be a pseudo-unimolecular process. The cutting of Cu in a solution of ferrous ions yielded ferric ions. The amount of ferric ions produced seems to depend on the quantity of O available in the solution. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182 : 539.27 : 539.501

3691. Fine structure and rheological properties of lithium soap-oil dispersions. B. W. HOTTEN AND D. H. BIRDSALL. *J. Colloid Sci.*, **7,** 284–94 (*June,* 1952).

Electron micrographs were taken of particles in lithium-soap/oil dispersions shadowed with chromium at 8000 magnification. The effect of composition and mode of preparation on the micelle structure is described. The gelling power was found to be related to the surface area per unit volume of the micelles. J. E. CAFFYN

541.182.6

3692. The sedimentation of dilute suspensions of microscopic spheres in water. B. W. WILSON. *Austral. J. appl. Sci.*, **3,** 252–6 (*Sept.*, 1952).

A continuous photographic method has been used to show that Stokes's law applies to the sedimentation of very dilute aqueous suspensions of closely sized

nicroscopic spheres in the range 2·5–10 microns in diameter. Temperature uniformity was a more critical factor than in the usual methods of particle-size analysis by sedimentation. A.

541.182.6 : 532.13

3693. Relationship between relative viscosity and volume concentration of stable suspensions of spherical particles. D. R. OLIVER AND S. G. WARD. Letter in *Nature* [*London*] **171,** 396–7 (*Feb.* 28, 1953).

An examination of the results of numerous workers has shown that the relative viscosity $= 1/(1 - kc)$ where k is a constant and c is the concentration of the spherical particles. Values of k obtained for the data of different workers range from 2·34 to 2·77 and the relationship normally holds for concentrations up to 20%. J. M. HOUGH

541.183

3694. Phase transitions in surface films on solids. R. N. SMITH. *J. Amer. Chem. Soc.*, **74,** 3477–9 (*July* 20, 1952).

Published isotherms of *n*-heptane on Fe_2O_3 and graphite have been redetermined using a gravimetric method and McLeod gauge instead of a volumetric method and cathetometer. The present results are at variance with the others in that no first- or second-order phase transitions are observed. A.

541.183

3695. Adsorption from binary mixtures: determination of individual adsorption isotherms. J. J. KIPLING AND D. A. TESTER. *J. Chem. Soc.*, **1952,** 4123–33 (*Nov.*).

In adsorption on solid surfaces from binary liquid mixtures, the isotherms for adsorption of the individual components cannot be represented by simple Freundlich or Langmuir equations. An analysis based on the assumption that the surface is completely covered with adsorbate at all concentrations gives results in agreement with those obtained by direct adsorption from the corresponding vapour phase. A kinetic treatment is proposed for this type of adsorption. Vapour-pressure data required in this work are recorded for the systems benzene-ethyl alcohol and benzene-ethylene dichloride at 20°C. A.

541.183

3696. Simple and multiple gas microintroductors for adsorption studies. J. C. P. MIGNOLET. *J. sci. Instrum.*, **30,** 15–17 (*Jan.*, 1953).

An improved microintroductor is described which enables measured volumes of gas from 0·2–50 mm^3 or more to be introduced into an apparatus at a low pressure. Several microintroductors can be combined together with an important reduction in complication. These simple and multiple microintroductors, using the mercury cut-off principle throughout, allow very pure gases to be handled without risk of contamination. They are well adapted for adsorption studies on evaporated films. A.

541.183

3697. Statistical mechanics of polymer adsorption. H. L. FRISCH, R. SIMHA AND F. R. EIRICH. Letter in *J. chem. Phys.*, **21,** 365–6 (*Feb.*, 1953).

Theoretical. The formation of a monolayer of the polymer on the surface of a dilute solution is considered by reference to (*a*) the statistics of deposition of a coiling molecule on the surface, and (*b*) the thermodynamics of the mixture consisting of empty sites, adsorbed segments of chains, bridges and solution. Conclusions are drawn as to the form of the isotherm and as to the heat of adsorption.

S. J. GREGG

CHEMICAL STRUCTURE 541.2/.6

541.24

3698. Molecular weight determination by thermistors. S. B. KULKARNI. Letter in *Nature* [*London*] **171,** 219–20 (*Jan.* 31, 1953).

At a condition of steady state, a constant difference in temperature exists between the droplets of solution and solvent deposited on the thermistor tips, and this difference can be measured as a difference of resistance in an a.c. bridge circuit. A pair of matched thermistors can thus be used for the determination of molecular weights of compounds soluble in organic solvents. When working with a pair of thermistors (Western Electric, type 14B) of *c.* 2000 ohms at 25°C, and using benzil as standardizing substance, the molecular weights obtained for naphthalene, camphor and phenanthrene (in benzene and toluene) with concentration of 0·5–7 g per 100 g of solvent differed very little from the theoretical values, the mean average deviation of the readings being ±0·25%. F. LACHMAN

541.5

3699. Electron distribution in molecules. I. F^{19} nuclear magnetic shielding and substituent effects in some benzene derivatives. H. S. GUTOWSKY, D. W. MCCALL, B. R. MCGARVEY AND L. H. MEYER. *J. Amer. Chem. Soc.*, **74,** 4809–17 (*Oct.* 5, 1952).

The influence of substituents on the electron distribution in benzene produces changes in the nuclear magnetic shielding of fluorine atoms in the molecule. A comparison of the F^{19} nuclear magnetic shielding in fluorobenzene with that in a substituted fluorobenzene is used in defining a δ-parameter. Experimental δ-values are reported for a considerable number of mono- and polysubstituted fluorobenzenes. An empirical correlation of δ-values for meta and para substituents with the corresponding Hammett substituent σ-constants reveals systematic differences which are attributed to the dependence of the δ-values on the nature of the electronic interactions of the substituent. Thereby, a detailed analysis of the δ- and σ-values for particular substituents permits evaluation of the nature of their electronic effects. Consideration of ortho substituents suggests that besides the usual inductive and electromeric effects at the meta and para positions, an additional interaction contributes to the δ_o-values in some cases. The potential uses and limitations of δ_o-values in evaluating ortho-effects and entropies of reaction are discussed. It is concluded from δ-values for polysubstituted fluorobenzenes that the electronic effects of substituents are usually remarkably additive but with significant non-additivity demonstrating interactions

between substituents in about a third of the compounds investigated. A δ'-parameter, analogous to δ, is defined in terms of the change produced by a substituent in the ring on the F^{19} nuclear magnetic shielding in benzotrifluorides. The δ'-values are about a tenth of the δ-values for the same substituent, indicating the extent of attenuation in the side chain of the substituent effects. Less conclusive discussions and comparisons are given of various other aspects of the data and experimental method. A.

541.5 : 539.132

Molecular orbital theory of chemical valency. *See Abstr.* 3510

541.5 : 539.132

Chemical valency theory and electronic structure of the methane molecule. *See Abstr.* 3511

541.553

3700. Relation between the new theory of directed valence and the geometrical notation of surroundings. R. DAUDEL AND C. VROELANT. *C.R. Acad. Sci.* [*Paris*] **236,** 78–81 (*Jan.* 5, 1953) *In French.*

The positions of the centres of gravity of electrons occupying the same shell in a given atom, are empirically related in geometrical diagrams to the number of electrons concerned. Bonding with other atoms in various spatial configurations illustrates the use of these diagrams. H. H. GREENWOOD

541.6 : 539.132

3701. A molecular orbital theory of organic chemistry. M. J. S. DEWAR. *J. Amer. Chem. Soc.*, **74,** 3341–63 (*July* 5, 1952).

I. General principles (3341–5). II. The structure of mesomeric systems (3345–50). III. Charge displacements and electromeric substituents (3350–3). IV. Free radicals (3353–4). V. Theories of reactivity and the relationship between them (3355–6). VI. Aromatic substitution and addition (3357–63).

541.6 : 539.132

3702. Molecular orbital theory of organic chemistry. M. J. S. DEWAR. *Sci. Progr.*, **40,** 604–24 (*Oct.*, 1952).

A review for non-specialists.

541.64 : 532.13

Implications of Philipoff flow curves for the determination of intrinsic viscosity of high polymer nitrocelluloses. *See Abstr.* 2985

541.64 : 548

3703. Morphology of crystalline synthetic polymers. A. KELLER. Letter in *Nature* [*London*] **171,** 170–1 (*Jan.* 24, 1953).

Spherulites formed when polyethylene and polyamides crystallize have been examined by polarized light and the results confirm earlier observations of the author [see Abstr. 6860 (1952)]. The polymers were crystallized from the melt between cover-glasses at a constant temperature within 20°C of the softening point. Polyethylene spherulites showed negative birefringence while the polyamide ones were positive. The author shows how this can be explained on the basis of close-wound spirals radiating from the centre of the spherulite. The molecular chains are consequently arranged tangentially and this is confirmed by an X-ray diffraction photograph of a circular area 30 μ diameter near the periphery of a spherulite of polyhexamethylene sebacamide. J. IBALL

541.67

3704. A magnetochemical study of amino-acids. R. PERCEAU. *C.R. Acad. Sci.* [*Paris*] **236,** 76–8 (*Jan.* 5, 1953) *In French.*

The magnetic susceptibilities of 12 α-amino-acids have been measured on a balance of the Weiss–Foex–Forrer type. In all cases the observed molar susceptibilities are less than the calculated values. G. I. W. LLEWELYN

LABORATORY APPARATUS 542.1/.7

542.47

3705. Intense drying of gases with potassium metal. E. R. HARRISON. *J. sci. Instrum.*, **30,** 38–9 (*Feb.*, 1953).

Gases such as N, H and the rare gases are dried by passing them through K vapour. The water vapour content is then estimated to be one part in 4×10^7 by volume, having a partial vapour pressure 2×10^{-5} mm Hg. Other impurities are also removed, as for example O, though no tests have been made to determine the degree of purification other than for water vapour. A.

542.47 : 537.226.3

3706. Laboratory drying of herbage by radio-frequency dielectric heating. J. N. MERRIDEW AND W. F. RAYMOND. *Brit. J. appl. Phys.*, **4,** 37–8 (*Feb.*, 1953).

Losses of dry matter from herbage during hot-air drying have been reported, and seem to be due to continued respiration of the herbage during the early stages of drying. These losses are reduced by more rapid drying. Preliminary tests showed that herbage can be rapidly dried by r.f. heating on the laboratory scale. The paper describes modifications made to a commercial r.f. oven to make it suitable for drying material of high moisture content. The oven will dry 300 g of herbage from 80% to 10–25% moisture content in 15 min. Comparative tests showed the r.f. oven to give an average dry matter yield ½% higher than that obtained by drying herbage in an efficient hot-air oven. A.

542.48 : 539.155.2

3707. The separation of isotopes by fractional distillation. I. Fractionating columns for the enrichment of the heavy isotopes of oxygen in water. I. DOSTROVSKY, D. R. LLEWELLYN AND B. H. VROMEN. *J. Chem. Soc.*, **1952,** 3509–17 (*Sept.*).

The construction and operation of a number of fractionating columns designed for the enrichment of the heavy isotope of oxygen in water are described. One is capable of producing, per day, 200 ml of 0·6% H_2O^{18}, or 50 ml of 1·7% H_2O^{18}, or 20 ml of 3·2% H_2O^{18}. Another, operating as a second stage, has produced 10 ml of 12% H_2O^{18} per week. A.

542.48 : 539.155.2

3708. The separation of isotopes by fractional distillation. II. Determination of parameters from production data. Value of the unit process separation factor for the $H_2{}^{16}O$–$H_2{}^{18}O$ system. I. DOSTROVSKY, J. GILLIS, D. R. LLEWELLYN AND B. H. VROMEN. *J. Chem. Soc.*, **1952,** 3517–24 (*Sept.*).

Application of the theory of fractional distillation

to the data obtained in the production of enriched isotopic materials makes it possible to derive simultaneously the values for the unit process separation factor, α, and the effectiveness of the column for the system used. A graphical method is presented which facilitates the derivation of such information from experimental data. The values of the unit process separation factors for the systems H_2O^{16}–H_2O^{18} and H_2O–HDO have been determined from the results of fractionation of water. A.

CHEMICAL ANALYSIS 543/545

545.8 : 551.574.1

Effect of halogens on the production of condensation nuclei by a heated platinum wire. *See Abstr.* 3776

CRYSTALLOGRAPHY 548

548.24

3709. Twin accommodation in zinc. P. L. Pratt and S. F. Pugh. *J. Inst. Metals*, **80**, 653–8 (*Aug.*, 1952).

A study of the plastic deformation of single crystals of Zn has been made, using the opaque-stop and X-ray microscopic techniques to examine cleavage faces. By these complementary methods, the stresses arising from the twinning shear are shown to be relieved by accommodation kinking. A.

548.5

3710. Etch-pits and dislocations. R. Gevers. Letter in *Nature* [*London*] **171**, 171–2 (*Jan.* 24, 1953).

A growth spiral is established on silicon carbide. After etching in fused borax it is shown that etch pits had been formed all along the spiral growth fronts. Growth spiral step height is determined by interferometry. At the end of the dislocation line a very deep etch pit (several wavelengths) is formed, showing that dislocation makes etching easier. The same has been found in topaz. S. TOLANSKY

548.5

3711. Screw dislocations in thin rods. J. D. Eshelby. *J. appl. Phys.*, **24**, 176–9 (*Feb.*, 1953).

In connection with Galt and Herring's observation on thin whiskers of Sn, the properties of a screw dislocation in a cylinder are worked out. When all boundary conditions are taken into account, the image force tends to keep the dislocation along the axis. Only when it is displaced about half-way to the surface does the image force tend to pull it out of the rod. Generators of the cylindrical rod become helices when the dislocation is introduced. The dislocation can be ejected from the rod by twisting or bending it suitably. A.

548.5

3712. The effect of added metallic impurity and of closed moulds on the growth from the melt of single crystals of tin. A. J. Goss. *Proc. Phys. Soc.* [*London*] *B*, **66**, 65–73 (*Feb.*, 1953).

A description is given of experiments on the crystallization of binary alloys of Sn. The alloys were prepared from 99·997% pure Sn to which known amounts (0·01–1%) of Cd, Zn, Pb, Ag, In or Sb were added. The effect of the added metal, as judged by the prevention of growth or by lack of perfection of the monocrystalline form, was found to depend on its solid solubility. Further experiments on the crystallization of the 99·997% pure Sn in closed Pyrex moulds, in which both horizontal and vertical travelling furnaces were used, are described. The results were the same as those for open moulds and the position of the metal was unimportant. A.

548.5 : 541.135.5

3713. The structure and orientation of calomel formed on liquid mercury by anodic polarization. H. R. Thirsk. *Proc. Phys. Soc.* [*London*] *B*, **66**, 129–33 (*Feb.*, 1953).

The electrochemical formation of HgCl on Hg in the presence of dilute HCl as electrolyte has been found to give rise to a surface orientation in which the a_0b_0 face diagonal and the c_0 axis of the tetragonal unit cell lie in the plane of the Hg. Fairly extensive single crystals may be formed or a more polycrystalline product may constitute the film, but in either case only {110} faces are found parallel to the substrate. Examples of twinning on {112} planes and rotational slip on {110} planes are noted in the growth of the film. The crystal orientation appears to be due to an approximately hexagonal arrangement of pairs of Hg and Cl atoms in {110} faces of the mercurous salt. Coherence of the film is assisted by the ready twinning and the presence of the {110} and {011} cleavage planes of the calomel. A.

548.5

3714. Nucleation. J. H. Hollomon and D. Turnbull. *Progress in metal physics*, Volume **4**, 333–88 (1953) [see Abstr. 3779].

A review, mainly on the rate of nucleation in reactions in crystalline solids. These are classified according to whether there are changes in (i) structure, (ii) structure and composition, (iii) structure and strain, (iv) structure, strain and composition, including accounts of theoretical work and of its success in interpreting the experimental results in representative cases. 92 references. E. P. WOHLFARTH

548.5 : 537.226

Report on researches with ferroelectric materials. *See Abstr.* 3286

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

3715. The formation of displacements. P. Fischer and A. Kochendörfer. *Z. Naturforsch*, **7a**, 735–41 (*Nov.*, 1952) *In German.*

Peierls's (1940) hypothesis is used to investigate the

formation by suitably placed forces of single displacements on the surface of an infinite half crystal. This gives an almost insoluble variation problem. The shape of the displacements is given as a first approximation, and the distribution of the forces is found graphically. Calculation shows that for a crystal thickness λ an energy of 1–2 eV must be surmounted to form a displacement. This agrees with Kochendörfer's experimental values. The calculated forces are very large, so that the formation can only be explained by a kind of notching. C. TURNER

548.7

3716. The statistics of a two-dimensional hexagonal net. J. P. HOBSON AND W. A. NIERENBERG. Letter in *Phys. Rev.*, **89**, 662 (*Feb.* 1, 1953).

These are appropriate for the discussion of the specific heat, C_v, of graphite at very low temperatures where the only contributing modes are propagated in the plane of the hexagonal sheets of C atoms. Closed expressions are given for the frequency distribution and for C_v as a function of temperature T. C_v is proportional to T^2. A. D. LE CLAIRE

548.7

3717. The electron in a weak periodic electric and a constant magnetic field. A. E. ZILBERMAN. *Zh. eksper. teor. Fiz.*, **23**, *No.* 1 (7) 49–54 (1952) *In Russian.*

The method of the "effective mass" (Peierls, 1933), used in the description of electronic states in a crystal, is verified to be applicable also in the case of weakly bound electrons in a magnetic field.

W. J. SWIATECKI

548.7

3718. The study of order-disorder changes in Cu–Pt alloys. G. FOURNET. *C.R. Acad. Sci.* [*Paris*] **235**, 1377–9 (*Dec.* 1, 1952) *In French.*

The change from the ordered to the disordered state is not accompanied by any notable change in the distribution of 1st nearest neighbours, so that simple theories are impotent in dealing with this case. An application of Yvon's theory [Abstr. 1702 (1948)], with the assumption that the difference $W(r_2)$ between the energies of interaction of like and unlike 2nd neighbours is greater than the corresponding value $W(r_1)$ for 1st neighbours, leads to results in good agreement with experiment. A. D. LE CLAIRE

548.7

3719. A study of the order-disorder transformation in iron-nickel alloys in the region $FeNi_3$. R. J. WAKELIN AND E. L. YATES. *Proc. Phys. Soc.* [*London*] *B*, **66**, 221–40 (*March*, 1953).

The order-disorder transformation in Fe–Ni alloys of high purity has been studied by measurements of electrical resistivity, by X-ray analysis and by an examination of the magnetic properties in both low and high fields. It is shown that the transformation appears to take place over a wide range of composition, from about 50 to 80 atomic % Ni, with a maximum change in structure-sensitive properties at 75 atomic % Ni. The formation of order is extremely sluggish and takes place in the temperature range 494°C to 500°C. The decrease in lattice parameter of the 75% alloy which occurs on the formation of the ordered structure is 2×10^{-3}Å. The existence of the superlattice was confirmed and, using the counter-spectrometer technique, an estimate of the degree of order was obtained. Low field magnetic measurements show that the maximum and initial permeabilities of $FeNi_3$ are decreased considerably by the annealing process known to produce the ordered alloy. The coercive force is increased by the same process. The effects of the addition of small percentages of Al, Cu, Mo and Mn to pure $FeNi_3$ have been examined. It is shown that the experimental results support the assumption that the "spare" electrons of the added elements enter the 3*d* shell of the Ni atoms only, the contribution of the Fe atoms to the total magnetic moment being unaltered. Thus the Fe and Ni atoms may be considered to act independently. A.

548.7

3720. On the incorporation of Mn ions in NaCl and KCl. P. BRAUER. *Z. Naturforsch.*, **7a**, 741–4 (*Nov.*, 1952) *In German.*

The energy states for Mn^{++} ions incorporated in NaCl and KCl are theoretically determined and show agreement with experimental results, viz. that the Mn ions more easily enter the NaCl than the KCl lattice. It also appears that a change to Mn^+ is not possible in KCl. The different behaviour of Mn^+ and Tl^+ is also given a theoretical explanation. G. F. J. GARLICK

548.7

3721. On the correlation between absorption band maxima of colour centres and lattice parameters in alkali halides. M. F. DEÏGEN. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 1, 126–7 (1952) *In Russian.*

Evidence is given for the relation $h\nu_F \cdot d^2 = K$ (a constant) between the frequency ν_F of the absorption maximum of the colour centre and d, the lattice parameter. It is further shown that $h\nu_F/\Delta E = \gamma$ (another constant) where ΔE is width of the forbidden zone of the crystal. For many halides (table given) $K = 1{\cdot}36 \pm 0{\cdot}06\times10^{-26}$ and $\gamma = 0{\cdot}26 \pm 0{\cdot}06$. The second relation is actually of wider application than the first. Thus for CaF_2 type $\gamma \simeq 0{\cdot}265$, for Cu_2O $\gamma \simeq 0{\cdot}30$ and for CsCl type about 0·23. A theoretical calculation from a simple crystal model gives $K = 0{\cdot}9\times10^{-26}$ for alkali halides, $0{\cdot}45\times10^{-26}$ for CsCl type (experimental value $0{\cdot}53\times10^{-26}$) and for CaF_2 type $0{\cdot}9\times10^{-26}$ (experimental, $1{\cdot}0\times10^{-26}$).

J. EWLES

548.7

3722. Ionic movements in crystals. A. SEEGER. *Z. Naturforsch.*, **8a**, 47–55 (*Jan.*, 1953) *In German.*

A theoretical paper, showing that among the solutions of Peierls's (1948) formula for screw displacements is a superposition of an infinite number of harmonic waves, which can result in very large distortions in a "glide plane." The largest possible movement of two neighbouring atoms is half the lattice constant. The connection is shown with Frenkel–Kontorova's model (1938) and its importance for the occurrence of pairs of displacements.

C. TURNER

548.7

3723. A theory of successive rotational transitions in crystals. T. J. KRIEGER AND H. M. JAMES. Letter in *J. chem. Phys.*, **21**, 176–7 (*Jan.*, 1953).

Investigates the dependence of the transition

henomena on the interaction potential function ssumed to have the form $E(\theta_{ij}) = AP_1(\cos\theta_{ij}) + BP_2(\cos\theta_{ij})$, where the P's are the Legendre polyomials, θ_{ij} is the angle between the axes of symmetry f the molecules, and A and B are adjustable parameters. The qualitative results of the Bragg–Williams pproximation have been confirmed. F. LACHMAN

548.7

724. Evidence for collapse of lattice vacancy aggregates to form dislocation rings. R. W. HOFFMAN, F. J. ANDERS AND E. C. CRITTENDEN, JR. Letter in *J. appl. Phys.*, **24**, 231–2 (*Feb.*, 1953).

Thin Ni films, evaporated on to mica, were annealed for fixed periods at successively increasing temperatures. The internal stresses, measured from the curvature of the mica substrates, decrease with temperature of anneal until *c.* 200°C and then increase. The decrease is interpreted as due to the coalescence of vacancies, and the increase from 200°C to the collapse of sheets of vacancies. Evidence is presented for the films being of normal metallic Ni.

A. D. LE CLAIRE

548.7

3725. Effect of *F*-centers on the internal friction of rocksalt single crystals. D. R. FRANKL AND T. A. READ. Letter in *Phys. Rev.*, **89**, 663 (*Feb.* 1, 1953).

Measurement by use of a piezo-electric oscillator shows that X-ray irradiation of NaCl crystals reduces their internal friction. Bleaching of the *F*- and *F'*-centres produced does not return the friction to its original value but this is approximately obtained by heating at 200°C for 30 min. Irradiation and *F*-centre production increases the resonance frequencies by a few parts in 10^4 and Young's modulus increases by 0·1%. G. F. J. GARLICK

548.7

3726. Saturation in the X-ray coloration of corundum single crystals. R. A. HUNT AND R. H. SCHULER. Letter in *Phys. Rev.*, **89**, 664 (*Feb.* 1, 1953).

Coloration of corundum by X-rays reaches a saturation level independent of dosage with bands at 230 mμ, 400 mμ and 650 mμ (weak). Comparison with *F*-centres in NaCl indicates that corundum contains fewer colour centres but that their absorption is similar to NaCl *F*-centres. G. F. J. GARLICK

548.7

3727. On the presence of free sodium in sodium chloride crystals containing color centers and color center precursors. M. HACSKAYLO AND D. OTTERSON. *J. chem. Phys.*, **21**, 552–3 (*March*, 1953).

The presence of "free sodium" in NaCl crystals containing colour centres and colour centre precursors, as indicated by the results of Hacskaylo and Groetzinger [Abstr. 8562 (1952)] has been confirmed by the use of a more precise method of chemical analysis. The present measurements were carried out by dissolving the crystals in question in a solution containing an indicator, *p*-nitrophenol, and determining the resulting change in the optical density of the solution at a wavelength of 415 mμ. The ratio of the number of "free sodium" atoms to vacancy pairs was about one for crystals which had been subjected to electrolysis and about one-tenth for crystals irradiated with X-rays, independent of whether these crystals had been first subjected to electrolysis. A.

548.7

3728. Effect of the Fermi energy on the stability of superlattices. J. F. NICHOLAS. *Proc. Phys. Soc.* [*London*] *A*, **66**, 201–8 (*March*, 1953).

When an alloy develops an ordered structure, new Brillouin zone boundaries are formed corresponding to the extra Bragg reflections. It is shown that, in this process, the Fermi energy is lowered, and this tends to stabilize the superlattice. The theory is applied to the superlattices in CuPt, CuAu and Ag_3Mg, where the ordered structures do not follow from the simple principle of lattice-strain relief. A.

548.7 : 541.5

3729. Positional relationship of valency electrons in crystal chemistry. K. SCHUBERT. *Z. Naturforsch.*, **8a**, 30–8 (*Jan.*, 1953) *In German.*

Shows in a number of crystal structures how this relationship can be used to investigate whether a phase occurs in a mixture. C. TURNER

548.7 : 537.533.9

3730. An effect of electron bombardment on order in Cu_3Au alloy. J. ADAM, A. GREEN AND R. A. DUGDALE. Letter in *Phil. Mag.*, **43**, 1216–18 (*Nov.*, 1952).

Strip samples, 0·0015 in. thick, initially well ordered by thermal treatment, show a decrease in resistance on annealing at 100°C after bombardment with 3×10^{17} 1 MeV electrons/cm.^{2} Neither the bombardment nor the 100°C anneal separately produce any change in resistance. It is suggested that the Frenkel defects, produced by electrons of this energy, make it possible to reach an equilibrium degree of order corresponding to a temperature lower than that obtainable in a reasonable time by purely thermal treatment. A. D. LE CLAIRE

548.7 : 539.164.9

3731. Radiation damage of beta-brass. R. R. EGGLESTON AND F. E. BOWMAN. Letter in *J. appl. Phys.*, **24**, 229–30 (*Feb.*, 1953).

An increase in resistance, measured at −146°C, of 5 mil foils on irradiation with 33 MeV α-particles at temperatures below −100°C (e.g. 50% increase after 10 μA.hr/cm^2) is interpreted as due to the creation of the disordered structure, not obtainable by quenching from above the critical temperature. The resistance decreases to its normal value after a short anneal at room temperature. A. D. LE CLAIRE

548.7 : 548.5 : 539.215.2

3732. Dislocations and the theory of solids. N. F. MOTT. *Nature* [*London*] **171**, 234–7 (*Feb.* 7, 1953).

An outline of the applications of dislocation theory in recent work, principally on crystal growth, plastic deformation and grain boundaries of solids.

A. D. LE CLAIRE

548.73/.74

3733. The polarization factor for inclined-beam photographs using crystal-reflected radiation. E. J. W. WHITTAKER. Note in *Acta Cryst.*, **6**, 222–3 (*Feb.*, 1953).

Derives the polarization factor in the general case

and expresses it in a form suitable for application to inclined-beam photographs on cylindrical films.

J. THEWLIS

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 3637–43

548.73

3734. Summarized proceedings of the fortieth anniversary celebrations of the discovery of X-ray diffraction—London, October 1952. H. LIPSON. *Brit. J. appl. Phys.*, **4**, 33–7 (*Feb.*, 1953).

A summary of the addresses is given in this report.

A.

548.73

3735. X-ray crystallographic technology. A. GUINIER. *London: Hilger and Watts.* xiii + 330 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 62 (Feb., 1953).

548.73 : 531.539.2

3736. An analogue for the demonstration of selective absorption of coupled wave-trains. W. KOSSEL. *Z. Naturforsch.*, **8a**, 24–7 (*Jan.*, 1953) *In German.*

There is an analogy between the interchange of energy between two pendulums which are coupled and damped, and the interchange of energy between an X-ray beam passing through a crystal and its Bragg-reflected beam. An arrangement of pendulums is described which can be used to show the behaviour of an X-ray beam in crystals of various thicknesses and absorption coefficients.

A. R. STOKES

548.733

3737. On the use of X-ray film for the quantitative measurement of diffraction line intensities. K. E. BEU. *Rev. sci. Instrum.*, **24**, 103–8 (*Feb.*, 1953).

The use of X-ray film for making quantitative measurements on diffraction lines or peaks is limited primarily by its granularity. The granularity characteristics of two typical commercial X-ray films were examined in terms of microphotometer records to help determine optimum conditions for detecting and measuring the intensities of small diffraction peaks as well as resolving the peaks. A criterion is suggested which relates film development conditions and film speed with the microphotometer scanning area required on the film in order to obtain these optimum conditions. Using this criterion, peak intensity measurements can be reproduced to about $\pm 1\%$ and integrated intensities to $\pm \frac{1}{2}\%$, or better.

A.

548.733

3738. Use of a Geiger counter for the measurement of X-ray intensities from small single crystals. H. T. EVANS, JR. *Rev. sci. Instrum.*, **24**, 156–61 (*Feb.*, 1953).

In a recent crystal structure study, new techniques for intensity measurements utilizing a Geiger counter have been developed and are described. The present application involves the adaptation of standard Geiger counter circuitry and equipment to a standard Weissenberg X-ray goniometer, so that diffraction intensities given by small (0·1 mm) single crystals are measured by means of a Geiger tube mounted in place of the film holder. The principle of measurement consists of the use of parallel collimated radiation and a scanning of the characteristic X-ray peak in order to obtain the integrated intensity. The measurement is made by totalizing counts on an impulse register while rocking the crystal, and correcting for background by measuring the ratemeter chart record which is made simultaneously with counting. Details of procedure and range of the method are given. The application of the method to the study of the crystal structure of tetragonal $BaTiO_3$ is described.

A.

548.733

3739. Crystal alignment on the Weissenberg goniometer. R. D. DRAGSDORF. Note in *Acta cryst.*, **6**, 220 (*Feb.*, 1953).

A method is described which is based on the use of the continuous X-ray spectrum. The crystal is oscillated through about 15° during an exposure. Two exposures are made, the crystal being turned through 180° between one exposure and the next.

J. THEWLIS

548.733

3740. A camera for texture mapping by X-ray diffraction. C. J. MILNER AND J. A. JAMES. *J. sci. Instrum.*, **30**, 77–83 (*March*, 1953).

Discusses various types of moving-film X-ray diffraction camera designed to give photographs which are in themselves recognizable maps of the reference sphere, though to projections different from the stereographic plot used in conventional pole figures. An instrument, a "texture mapping camera," has been built embodying a preferred form of this type of apparatus and details are given of its construction and operation, and of the preparation of specimens, together with some results obtained with the instrument on grain-oriented silicon-iron sheet. The technique described is advantageous in increasing the speed and objectivity of recording texture.

A.

548.734

3741. Study of boehmite–hydrargillite mixtures. C. LEGRAND, L. TERTIAN AND R. TERTIAN. *C.R. Acad. Sci.* [*Paris*] **236**, 392–4 (*Jan.* 26, 1953) *In French.*

Reflection and transmission photographs have been used to determine the ratio of $Al_2O_3.H_2O$ to $Al_2O_3.3H_2O$ from the ratio of intensities of powder lines. Both methods are found equally convenient.

A. R. STOKES

548.734.8

3742. The Cox and Shaw factor. E. J. W. WHITTAKER. Note in *Acta cryst.*, **6**, 218 (*Feb.*, 1953).

A new and more precise expression is obtained for the correction of observed X-ray intensities in cases of oblique incidence on film with thick emulsion.

A. R. STOKES

548.735.44

3743. A "zero" synthesis for Fourier refinements. A. D. BOOTH. Letter in *Nature* [*London*] **171**, 168–9 (*Jan.* 24, 1953).

The "difference" synthesis of $|F_{obs.}| - |F_{calc.}|$ [Abstr. 3013 (1948)] gives useful information even when used with only those terms having $|F_{obs.}| = 0$, for which the lack of knowledge of phase is of no consequence.

A. R. STOKES

548.736.4

744. Existence of a spinel 1 : 4, with mono- and tetravalent cations. F. BERTAUT AND A. DURIF. *C.R. Acad. Sci.* [*Paris*] **236,** 212–14 (*Jan.* 12, 1953) *In French.*

Spinels with cation valency ratios 3 : 2, 4 : 2, 3 : 1 and 6 : 1 are known; a compound with approximate composition $7TiO_2.2Li_2O$, formed by heating TiO_2 with excess Li_2CO_3 at 900°c for 2 days, appears to be the first with ratio 4 : 1. Its powder pattern resembles that of MgO more than that of an ordinary spinel. Intensity considerations suggest that 8 Li are in the tetrahedral positions, with 14 Ti and 2 vacancies in the octahedral, and that the O parameter is somewhat greater than $\frac{3}{8}$. A. J. C. WILSON

548.736.5

745. Morphology and structure of reddingite, $P_2O_5.3FeO.3H_2O$. P. EVERSHEIM AND W. KLEBER. Note in *Acta cryst.*, **6,** 215–16 (*Feb.*, 1953) *In German.*

Orthorhombic, *Pcmb*, $a = 8{\cdot}73$, $b = 10{\cdot}15$, $c = 7{\cdot}57$ Å. 4 formula units per cell. Atomic positions are given and two projections shown. A. R. STOKES

548.737

746. Crystal structures of gutta percha. D. FISHER. *Proc. Phys. Soc.* [*London*] *B,* **66,** 7–16 (*Jan.* 9, 1953).

Thin films of gutta percha have been examined by means of electron diffraction, and shown to exist in three distinct crystalline forms, termed the α, β and γ modifications, whereas prior to this work only two forms had been recognized. The conditions necessary for the occurrence of the different forms are considered and probable unit cells are suggested for two of them. These have the dimensions: β form: $a = 7{\cdot}83$ Å, $b = 11{\cdot}87$ Å, $c = 4{\cdot}75$ Å, $\alpha = \beta = \gamma = 90°$. γ form: $a = 5{\cdot}9$ Å, $b = 7{\cdot}9$ Å, $c = 9{\cdot}2$ Å, $\alpha = \beta = 90°$, $\gamma = 94°$. Data from the α modification were insufficient to provide the full set of lattice constants but the identity period along the chain axis was found to be 8·76 Å. The β form which provides the most data has received much previous study and the present figures show broad agreement with those of previous workers. The three identity periods of 8·76 Å, 4·75 Å and 9·2 Å are in close agreement with those predicted by Bunn (1942) on the basis of theoretical considerations of the possible configurations of a transpolyisoprene chain. A.

548.737

747. Sketch of the structure of triphenylmethyl bromide. J. LANDAIS. *C.R. Acad. Sci.* [*Paris*], **236,** 94–6 (*Jan.* 5, 1953) *In French.*

Trigonal, $C\bar{3}$, $a = 13{\cdot}85$, $c = 13{\cdot}42$ Å, measured density 1·416, $Z = 6$. Weissenberg photographs with Cu$K\alpha$. Patterson projections give the positions of Br and the orientation of the phenyl groups; the molecule has a threefold axis. A. J. C. WILSON

548.737

748. Crystal structure of *iso*nicotinic acid hydrazide. L. H. JENSEN. Letter in *Nature* [*London*] **171,** 217–18 (*Jan.* 31, 1953).

Orthorhombic, $P2_12_12_1$, $a = 11{\cdot}33$, $b = 14{\cdot}74$, $c = 3{\cdot}84$ Å; 4 mols per unit cell. xy co-ordinates and an electron-density projection on the (001) plane are given. A. R. STOKES

548.737

3749. Diffuse spots of pyrene at higher temperatures. M. N. DUTT. Letter in *J. chem. Phys.*, **21,** 380–1 (*Feb.*, 1953).

A pyrene crystal, space group C_{2h}^5, shows extra Laue reflections from $(\bar{3}10)$ and $(\bar{3}11)$ planes, increasing in intensity with rising temperature (from 30° to 100°c). The variation of structure factor amplitude of the two planes is different. The crystal lattice is distorted above 125°c. C. TURNER

548.737

3750. Thermal diffuse scattering of X-rays from single crystals of benzil. R. K. SEN. Note in *Acta cryst.*, **6,** 219 (*Feb.*, 1953).

Reports the shapes of the equi-scattering surfaces around the reciprocal lattice points of benzil. The results are in qualitative agreement with the theories of thermal diffuse scattering developed by Born and by Zachariasen. J. THEWLIS

548.737

3751. The unit cells of four proteins. F. H. C. CRICK. Note in *Acta cryst.*, **6,** 221–2 (*Feb.*, 1953).

X-ray diffraction from "wet" crystals gave the following data: (*a*) Trypsin inhibitor (mol. wt. ~ 9000) hexagonal, $a = 111$ Å, $c = 122$ Å, probable space group $C\,6_22$, probably 60 molecules per unit cell. (*b*) Compound of trypsin and trypsin inhibitor (mol. wt. ~ 30 000) monoclinic, $a = 113$ Å, $b = 123$ Å, $c = 75$ Å, $\beta = 139°$, space group $A2$, 10 molecules per unit cell. (*c*) Lysozyme nitrate, monoclinic, $a = 27{\cdot}9$ Å, $b = 63$ Å, $c = 66{\cdot}6$ Å, $\beta = 114{\cdot}5°$, 4 molecules per unit cell. (*d*) Lysozyme iodide has a very similar unit cell to (*c*). Since the asymmetric unit in each case contains more than one molecule it is considered unlikely that more detailed examination would be worth while. J. IBALL

548.737

3752. Crystal structure of histidine hydrochloride monohydrate. J. DONOHUE. Letter in *Nature* [*London*] **171,** 258–9 (*Feb.* 7, 1953).

Orthorhombic, $P2_12_12_1$, $a = 15{\cdot}36$, $b = 8{\cdot}92$, $c = 6{\cdot}88$ Å, 4 mols per unit cell. A structure has been obtained from the three-dimensional Patterson function; electron-density projections are given. A. R. STOKES

548.74

3753. Design of a high-resolution electron diffraction camera. J. M. COWLEY AND A. L. G. REES. *J. sci. Instrum.*, **30,** 33–8 (*Feb.*, 1953).

The conditions governing high resolving power in electron diffraction cameras are discussed, and, in particular, those determining the quality of resolution of the fine-structure in single-crystal reflections. Limitation of resolution may arise from large source size, instability of electrical supplies, misalignment of the electron-optical system, interference from mechanical vibration and stray magnetic fields, grain in the photographic emulsion or too high an operating gas pressure in the camera. A camera designed to minimize these limitations is described, and its performance illustrated. Detailed fine structure, such

as the subsidiary maxima of the shape transforms for small crystals, has been resolved. A.

548.74

3754. The flow of particles in space-lattice diffraction of matter waves. M. v. Laue. Note in *Acta cryst.*, **6**, 217 (*Feb.*, 1953) *In German.*

The density of particle flow is given by an expression similar to that found [Abstr. 9162 (1952)] for the energy flow of X-rays in a thick crystal set at the diffracting position. A. R. STOKES

548.74 : 539.185

3755. Some aspects of neutron single crystal analysis. R. Pepinsky. *Science*, **117**, 1–3 (*Jan.* 2, 1953).

Discusses Fourier methods in neutron analysis, the influence of extinction, phase determination and marked atom methods. It is concluded that neutron diffraction may on occasion provide a direct approach to an unknown structure, without the help of X-ray methods, and that Fourier methods have a considerable value, especially where the atoms are, for the most part, not in special positions. J. THEWLIS

548.74 : 539.185

3756. Neutron diffraction study of the NaCl-type modification of ND_4Br and ND_4I. H. A. Levy and S. W. Peterson. Letter in *J. chem. Phys.*, **21**, 246 (*Feb.*, 1953).

A study of the orientation of the $[NH_4]$ ion. A model involving freely rotating ions is ruled out by the neutron intensities. These, together with evidence from heat-capacity measurements and infrared absorption data, lead to the suggestion that the $[NH_4]$ ion rotates about a single threefold axis of the ion, which is oriented along a fourfold axis of the crystal. J. THEWLIS

548.74 : 539.27

Electron microscopy and diffraction study of the behaviour of silver bromide under the action of fast electrons. *See Abstr.* 3643

GEOPHYSICS 55

550.361

3757. Temperature-pressure hypothesis and the earth's interior. J. A. Jacobs. *Canad. J. Phys.*, **31**, 370–6 (*March*, 1953).

Bullen and Ramsey have shown that the reciprocal of the compressibility is a linear function of the pressure both in the earth's core and in the mantle below 1000 km. In view of this result, it seems reasonable to suppose that a similar relationship exists between the reciprocal of the volume coefficient of thermal expansion and pressure. Support for this hypothesis is obtained by two independent methods (*a*) using Uffen's results based on the theory of solids, (*b*) using Murnaghan's theory of finite strain. Assuming the validity of the hypothesis, an estimate is made of the adiabatic gradient throughout the earth. Taking the temperature at 1000 km to be 3600°K, values of the temperature at greater depths are estimated. In particular it is found that the temperature at the boundary of the core is 4350°K, and at the centre of the earth a little over 4800°K. These results have considerable interest and bearing on Bullard's theory of the transfer of heat from the core. A.

550.381

3758. On the origin of inversions of magnetization found in rocks in the Auvergne. A. Roche. *C.R. Acad. Sci.* [*Paris*] **236**, 107–9 (*Jan.* 5, 1953) *In French.*

Specimens taken from lava flows from Mont Coupet (upper Pliocene) and Vernines (upper Miocene), showing reversed magnetization, were slowly heated. The demagnetization proceeded gradually and progressively from 200°C upwards, without any abrupt change until the Curie point (585°) was reached. The baked clays underlying several lava flows were examined and were found to have the same reversed magnetization as the flows themselves. These facts suggest that the reversed magnetizations are not due to any mechanism inherent in the nature of the rocks themselves, but originate from the geomagnetic field itself being reversed at the time the rocks were laid down. A. T. PRICE

550.384 : 525.35

On variations of the geomagnetic field, fluid notion, and the rate of the Earth's rotation, *See Abstr.* 2919

550.835

3759. An analysis of airborne surveying for surface radioactivity. J. C. Cook. *Geophysics*, **17**, 687–706 (*Oct.*, 1952).

Quantitative estimates of the γ radiation field intensities expected to be encountered in flight over various geologic bodies are presented. Scattering effects are included in the calculations, but several simplifying assumptions were necessary, such as assigning equal energies to all photons. Results are compared with Geiger counter measurements of three kinds: near a small natural carnotite deposit, near a tenth-curie of radium, and soundings made over normal terrain at various times. It appears that anomalies from most outcrops of radioactive ores will exceed the normal fluctuations of background radiation due to topography, variations of composition of the surface, etc., only at flying altitudes of less than about 35 feet. However, such anomalies can probably be detected under favourable conditions by their characteristically pointed shape, all flowing flight at higher elevations. Requirements on flight plan and instrumentation are discussed. A.

550.835

3760. Simultaneous gamma-ray and neutron logging. G. Swift. *Geophysics*, **17**, 387–94 (*April*, 1952).

Newly developed instrumentation for radioactivity well logging is described whereby two curves, the γ-ray curve and the neutron curve, are made simultaneously, together with a record of the casing collar positions, on one upward passage of the logging

nstrument. A functional description of all of the ystem elements is provided, showing how the result- ng log is continuously drawn in the surface vehicle on n multi-pen recorder, with consequent saving in rig- ime and elimination of possible depth discrepancy etween curves, which may exist where successive runs are required. The application of radioactivity logs o production problems is briefly discussed. A.

550.837.6 : 621.396.1

3761. The interpretation of electromagnetic reflection data in geophysical exploration. I. General theory. W. J. YOST. *Geophysics*, **17**, 89–106 (*Jan.*, 1952).

It is shown that any variable current method of electrical exploration must be interpreted in terms of a semi-infinite conducting medium underlying a semi-infinite insulator. The complete theoretical treatment for a homogeneous conductor is outlined, and the details of the solution for low frequencies are presented. These indicate that the measured field intensities are not in-phase with the exciting current as has previously been assumed. These out-of-phase components from a homogeneous earth complicate the desired interpretation in terms of resistivity discontinuities at depth. The results of this paper provide a means of suitably correcting for this factor. Secondly, the insulating (air) region is shown to have an influence on the electromagnetic fields within the conductor. Thus, when considering the image approximation, the images are influenced by the air region and cannot be assumed to behave as they would in an infinite conductor. The lack of validity of this earlier assumption is demonstrated and suitable correction factors are derived. Specific results for the two cases of most practical interest are presented in graphical form. These are compared with experimental data obtained from a laboratory scaled model composed of metallic plates. A.

550.837.6 : 621.396.1

3762. The interpretation of electromagnetic reflection data in geophysical exploration. II. Metallic model experiments. W. J. YOST, R. L. CALDWELL, C. I. BEARD, C. D. MCCLURE AND E. N. SKOMAL. *Geophysics*, **17**, 806–26 (*Oct.*, 1952).

A metallic model of a horizontally stratified section of the earth's crust has been constructed to provide information of considerable value in the interpretation of geophysical data. Modelling considerations and experimental arrangements are discussed in detail for a system employing loops of wire as transmitter and receiver for the study of propagation of electromagnetic energy in and on a semi-infinite conductor. An experimental check of the theory given in Pt I has been made for the case of a semi-infinite conducting medium underlying a semi-infinite insulator. Discontinuities in electrical conductivity within such a medium have been shown to reflect electromagnetic pulses back to the surface. A detailed study of the shape of these pulses from single reflectors has been made, showing that certain characteristics of the pulse shape can be correlated with the depth and nature of the reflecting horizon. The reflected signals can be approximately described by considering the discontinuities as reflectors which, in turn, can be replaced by virtual "image" oscillators in a homogeneous structure. The extent to which this approximation holds is discussed in the light of experiments with the model. An example is given of the use of a non-concentric loop arrangement for geophysical profiling of a limited reflector, such as a salt dome. Finally, data are given to show the agreement between model signals and field results obtained from a known resistivity contrast in the earth. A.

550.837.7 : 621.3.011 : 621.396.11

3763. Attenuation of radio frequency waves through the earth. W. C. PRITCHETT. *Geophysics*, **17**, 193–217 (*April*, 1952).

Evidence has been presented by several investigators indicating the possibility that radio waves penetrate sufficiently deep into the earth to be useful in prospecting for oil. Conventional electromagnetic theory used with normal values of the earth constants indicates, however, that the attenuation is too great to allow the signal to be used after propagation through significant distances of shale. To settle the above question the signal level in the earth was measured at various distances from a battery-operated transmitter operating at 1652 kc/s suspended in an uncased, mud-filled hole by a mud-saturated rope. The mud resistivity was matched to that of the 40-ft thick shale section used in order that the entire immediate region would be as nearly as possibly homogeneous. The receiver was also battery-operated and suspended by a cable in other similar mud-filled holes at various distances from the first hole. The attenuation constant in shale was found to be 0·231 neper/ft (2 db/ft), which is much too large to give any hope of deep penetration. A few measurements in a limestone section gave a value of 0·086 neper/ft, which is also too large to be useful. Although these values are quite high, they are lower than theory predicts for these earth resistivities by a factor of about two. A.

550.93

3764. A new technique for the measurement of age by radiocarbon. H. DE VRIES AND G. W. BARENDSEN. Letter in *Physica*, **18**, 652 (*Aug.–Sept.*, 1952).

The carbon was used as CO_2 at 2 atm. pressure in a proportional counter. Results were much better than with a screen wall counter. F. R. HOLT

550.93

3765. The maximum age of the elements and the age of the earth's crust. C. B. COLLINS, R. D. RUSSELL AND R. M. FARQUHAR. *Canad. J. Phys.*, **31**, 402–18 (*March*, 1953).

Estimates are given of a maximum time of formation of the elements of 5·5 billion years and of the time of formation of the earth's crust at 3·5 billion years. These estimates were based on the isotopic constitution of Pb ores dated from isotopic analysis of radiogenic Pb's from U minerals. Methods of calculation are described. Experimental measurements of the isotopic constitution of Pb from mass spectrograms of Pb tetramethyl are reported with examples. A.

551.465 : 532.59

Gravity waves. *See Abstr.* 2998

ATMOSPHERE . METEOROLOGY 551.5

551.501 : 551.511

3766. Values of some physical functions and constants used in meteorology. *Org. Météorol. Internat., Publ. No.* 79, 1–43 (1951).

This report of a Sub-Commission of the Aerological Commission, O.M.I., recommends values to be used in meteorology with particular reference to synoptic practice and the thermodynamics of the atmosphere. The principles adopted in the choice of units are consistent with (*a*) the results of modern laboratory techniques and physical theory, (*b*) thermodynamic logic, (*c*) theoretical and practical requirements of meteorology, and (*d*) the choice of magnitudes of physical quantities adopted in recent years by physicists and engineers, in particular with those recommended by Birge (1941) and by the Working Sub-Committee of the International Joint Committee on Psychrometric Data. The corresponding values adopted by the Conference of Directors of Meteorological Services, Washington, 1947, are also quoted and, while largely in agreement, some small approximations were considered acceptable in particular for values of the saturation vapour pressure over supercooled water. R. S. READ

551.508.1 : 551.508.4

3767. A barometer element for radio-sondes. H. V. NEHER. *Rev. sci. Instrum.*, **24**, 97–8 (*Feb.*, 1953).

The barometer unit described herein has proved to be extremely reliable when used on balloon flights to high altitudes. It consists of an aneroid element which moves an arm, making a series of contacts with no mechanical amplification involved. Working on the digital principle it gives its information when certain definite pressures have been reached. A.

551.508.43 : 537.591.08

3768. The use of a simple barograph in cosmic ray balloon flights. N. L. ALLEN AND E. PICKUP. *Canad. J. Technol.*, **30**, 317–20 (*Dec.*, 1952).

A self-recording barograph has been constructed and used successfully in determining the time-altitude records for free balloon flights carrying nuclear research emulsions to altitudes of about 100 000 ft. A.

551.510.3

3769. Air mass between an observer and outer space. E. C. PRESSLY. Letter in *Phys. Rev.*, **89**, 654 (*Feb.* 1, 1953).

Calculations have been made of the total mass of air contained in a column of unit cross-section along a path of given zenith angle from outside the earth's atmosphere to a specific station within the atmosphere situated at a given height above the earth's surface. Upper atmospheric density data obtained by Havens from rocket experiments up to 220 km over White Sands have been used. Results are given in tabular and graphical form for various zenith angles and various altitudes, and indicate that different conditions prevail in the upper atmosphere over different stations. G. M. BROWN

551.510.535

3770. The stratification $F_{1\cdot5}$ at Dakar and the motion of the sun. F. DELOBEAU. *C.R. Acad. Sci. [Paris]* **235**, 1673–5 (*Dec.* 22, 1952) *In French.*

Following the nomenclature of the military ionospheric prediction service, the stratification of the *F*-layer which often appears in subtropical regions in addition to F_1–F_2 bifurcation is denoted by $F_{1\cdot5}$. Measurements of the critical frequency and minimum virtual height of this layer are difficult, because the separation of the three layers in height is rarely complete. Existence of $F_{1\cdot5}$ involves a marked lowering of the degree of maximum ionization of the F_1 and F_2 layers. Graphs are given showing the diurnal and annual variations of the number of appearances of $F_{1\cdot5}$ at Dakar. For all seasons there is a maximum at local noon, and over the period July 1949–July 1952 the annual variations show maxima in summer and minima in winter, and appear to follow the general decrease of sunspot number. There also appear subsidiary maxima near April and August, and it may be necessary to consider the influence of magnetic characteristics on the formation of $F_{1\cdot5}$. G. M. BROWN

551.510.535

3771. Angle of arrival of *Z* echoes. G. R. ELLIS. Letter in *Nature [London]* **171**, 258–9 (*Feb.* 7, 1953).

Measurements made at Hobart (mag. lat. 51°S) during July–August 1952 on 4·65 Mc/s to test Scott's hypothesis [Abstr. 6189 (1950)] that the weak third *F*2 penetration frequency (*Z* mode) observed at high magnetic latitudes is due to longitudinally propagated waves reflected from an area near the magnetic zenith. The *Z* echo reflection height was 170–210 km, and mean direction 7·8°N of the vertical in the magnetic plane. These results are inconsistent with the collisional frequency required on Scott's theory. G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 3461–6

551.513

3772. Measurements of the water vapor transport and distribution within unstable atmospheric ground layers and the turbulent mass exchange coefficient. A. F. BUNKER. *Paper phys. Oceanogr. Meteorolog.*, **12**, 42 *pp.* (*Dec.*, 1952).

Temperature, humidity and roughness measurements were made from an aeroplane flying through the ground layer of continental air blowing over warmer water. The soundings extended up through the well-mixed, turbulent ground layer, usually 1200 m thick, and through the sharp inversion which separates the ground layer from the more stable atmosphere above it. The accumulation of water vapour beneath the inversion is obtained from soundings taken at increasing downwind distances up to 150 km from shore. The flow of water vapour through unit horizontal surfaces at the water surface and at 200 m is found to vary within the ranges $2{\cdot}6\times10^{-6}$ to 91×10^{-6} and $0{\cdot}9\times10^{-6}$ to 43×10^{-6} g cm^{-2} sec^{-1} respectively. Mixing ratio gradients found were in the ranges -60×10^{-9} to $0{\cdot}0\times10^{-9}$ cm^{-1} and -24×10^{-9} to $1{\cdot}0\times10^{-9}$ cm^{-1} in the bottom and upper friction regions over the water. Values of the gradient and flow have been substituted in the diffusion equation $E = -A\partial q/\partial z$. The coefficient of turbulent mass exchange lies in the range 68 to 2500 g.cm^{-1} sec^{-1} in the slightly stable range and 780 to 15 000 g.cm^{-1} sec^{-1} in the neutral or

nstable range. A fair empirical measure of the oefficient is given by the wind speed divided by 1 + absolute value of the stability). Vertically, n average coefficient, from smoothed gradient and low curves, increases from the molecular values of iffusivity at the water surface to a maximum of 350 g.cm^{-1} sec^{-1} at 10% of the height of the ground ayer inversion, but with a slow decrease to 100 g. m^{-1} sec^{-1} at 88% of the inversion height. The oefficient drops to 1 to 10 g.cm^{-1} sec^{-1} through the nversion. The linear representation of the variation of the coefficient in each of the many subdivisions of he ground layer is a good approximation. The nfluence of free-convection, considered as a process distinct from eddy diffusion, on the transport of water vapour, is evaluated. It is shown that the upward ransport by diffusion may be reversed in the few 100 m below the base of a strong inversion. This eversal results from the production of a positive mixing ratio gradient below the inversion base by he sudden halting of the moist convective currents which build up the moisture concentration above the concentration reached at the intermediate levels.

R. S. READ

551.521.63 : 551.510.4

3773. Ultraviolet radiant energy from the sun observed at 11 190 feet. R. STAIR. *J. Res. Nat. Bur. Stand.*, **49**, 227–34 (*Sept.*, 1952).

Measurements made in September, 1951, at Climax, Colo., altitude 11 190 ft. Data are given for wavelengths extending from 535 to 299·5 mμ for a number of air masses from 0 to 3·0. A determination of atmospheric transmittance as a function of wavelength results in calculated amounts of ozone approximating 0·21 cm (N.T.P.) for several days during September. This value is in good agreement with previous determinations by other methods, for the season of the year and the geographical latitude of Climax. A.

551.57

3774. Definitions and specifications of water vapour in the atmosphere. *Org. Météorol. Internat., Publ. No.* 79, 45–92 (1951).

This report of a sub-commission of the Aerological Commission, I.M.O., aims to provide definitions for the various quantities used which are self-consistent and devoid of ambiguities. The principles applied are that (*a*) the quantities specified shall ideally be capable of measurement by standard laboratory techniques, (*b*) thermodynamic logic is satisfied, (*c*) theoretical and practical requirements of meteorology are satisfied, and (*d*) agreement obtained with the specifications adopted in recent years by physicists and engineers. The resolution adopted by the Conference of Directors of Meteorological Services, Washington, 1947, for these definitions and specifications is quoted and there are a few small differences from the Sub-Commission's recommendations.

R. S. READ

551.574.1

3775. Condensation nuclei produced by ultraviolet light. J. J. MCHENRY AND S. TWOMEY. *Proc. Roy. Irish Acad. A*, **44**, *No.* 3, 51–9 (*May*, 1952).

The formation of condensation nuclei in moist air, N_2 and O_2, and in moist air with NH_3 as an impurity was tested with a Nolan–Pollak nucleus counter. The effective wavelength for the production of a measurable concentration of nuclei was found to lie between 2345 and 2399 Å and probably between 2345 and 2378 Å, with or without the presence of NH_3. It is concluded that NH_3 is the chief agent for nucleus production by u.v. light in moist air. The spectroscopic evidence is reviewed and the initial states of nucleus formation and water formation discussed. R. S. READ

551.574.1 : 545.8

3776. Effect of halogens on the production of condensation nuclei by a heated platinum wire. B. VONNEGUT. *Science*, **117**, 108–9 (*Jan.* 30, 1953).

The presence of small traces of halogens in the atmosphere causes a very large increase in the rate at which condensation nuclei are produced from a filament at 500°C. It is suggested that the reaction compounds produced at the surface have a much higher vapour pressure than platinum at this temperature. The possibility of developing the method for trace analysis is suggested. J. M. HOUGH

551.593 : 535.338.4

Forbidden transitions in the spectra of diatomic molecules. *See Abstr.* 3112

551.593.7

3777. Calculation of the polarization of a sunlit sky composed of pure air molecules. A. HAMMAD. *J. Opt. Soc. Amer.*, **43**, 184–7 (*March*, 1953).

An exact solution of the complex and difficult problem of the illumination of the atmosphere and ground by sunlight is discussed in the light of numerical results. Full account is taken of the polarization of radiation by scattering, and allowance is made for the optical anisotropy of the molecules of air. The atmosphere is supposed to be uniformly mixed and stratified in parallel planes. Predictions based on that solution are put to the test of observation. The neutral points are found to occur in the manner they are observed. The incomplete polarization of the light scattered at right angles to the incident solar beam is fully accounted for, assuming a depolarization factor equal to 0·0415 for the molecules of air. Solutions taking no consideration of that factor fail to account for the observed depolarization. The observations of Tichanowsky on the degree of polarization of zenith scattered light are also accounted for when the optical anisotropy of the molecules of air is taken into consideration. A.

551.593.9

3778. Investigations on bright night sky and luminous bands. C. HOFFMEISTER. *J. Brit. Astron. Soc.*, **62**, 288–92 (*Oct.*, 1952).

An abridgement of a monograph published recently [*Ergebnisse der exakten Naturwissenschaften*, **24**, 1 (1951)], comprising a summary of 30 years' observation of luminous night skies; and a theory of their origin. Four characteristic types of luminescence are recorded. Height of the emitting layer varies between 90 and 180 km with max. frequency of occurrence at 120–130 km. The origin of the luminous cloud- or band-like structures is explained as being caused indirectly by impact of meteoritic particles on the high atmosphere, the intensity of

emission being controlled by the degree of ionization produced in the ionosphere by solar u.v. radiation.

D. R. BARBER

551.593.9 : 527 : 523.821

The visibility of stars and planets during twilight. *See Abstr.* 2915

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669 : 548

3779. Progress in metal physics. Volume 4. Edited by B. CHALMERS. *London: Pergamon Press* (1953) 403 *pp.*

For Vol. 3, see Abstr. 8617 (1952). For abstracts of separate chapters see Abstr. 3627, 3630, 3636–7, 3648, 3674, 3714

E. P. WOHLFARTH

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771.535

3780. Some experiments on photographic sensitivity. J. M. HEDGES AND J. W. MITCHELL. *Phil. Mag.*, **44**, 357–88 (*April*, 1953).

A technique is described for the preparation of optically clear silver bromide in the form of thin plane parallel sheets with flat surfaces. These sheets have been used to investigate the formation of the latent image under illumination. It has been found that the distribution of the latent image between the surface and the interior of the crystals depends on their physical properties, on the nature of the sensitizing layers present on their surfaces, and on the exposure. A surface latent image is formed, together with a weak internal latent image, when well annealed crystals are exposed to light. A surface latent image, on the other hand, is not formed with strained sheets of pure silver bromide, if they have not been annealed at all or only at low temperatures. With such material, an internal latent image is formed by the separation of silver along dislocation lines, which may form the boundaries of an irregular polyhedral structure. The crystals may then be developed after the dissolution of the surface with a solvent for silver bromide. Crystals which give a strong internal imag and no surface latent image may be sensitized for th formation of a surface latent image by the condensa tion on their surfaces of thin films of silver, gold an of certain metallic sulphides from atomic or molecula beams. After a brief exposure to light, a surfac latent image is formed on the sensitized crystals whic can be developed to a normal negative image (blac in the exposed regions). Longer exposures cause th disappearance of the surface latent image in th exposed areas and the formation of a surface late image in the unexposed areas. The reversed or pos tive image (white in exposed regions) can also b developed. This behaviour corresponds to solariza tion in the photographic process. The internal late image did not show any trace of reversal or solariza tion even after very prolonged exposures. The thi films of the sensitizer are shown to provide traps fc positive holes but not for electrons. This seems t be the role of the chemical sensitizers. The recogn tion of this fact necessitates a revision of the ideas o sensitivity specks which have previously been acceptec It is now suggested that sensitivity centres rather tha specks are involved and that these are regions c localized structural imperfection. The traps for th electrons are provided by the silver ions associated wit them. All the experimental evidence is consisten with the hypothesis that the latent image consists o a group of silver atoms exceeding a critical size an situated either on the external surface or on an interna surface associated with a mechanical imperfection o the crystal (e.g. a dislocation). The experimenta results lead to a new working hypothesis on th formation of the latent image in silver bromid crystals which appears to account satisfactorily for (1) the distribution of the latent image between th surface and the interior of the crystal under differen circumstances; (2) the formation of the latent sub image and its transformation to a stable latent image (3) low and high intensity reciprocity failure and th influence of chemical sensitization upon them; an finally, (4) solarization.

A

778.34 : 537.534.7

The range-energy relation for protons and alpha particles in diluted Ilford G5 emulsions. *See Abstr.* 3370

778.34 : 537.534.7

The range correction for electron pick-up. *See Abstr.* 3371